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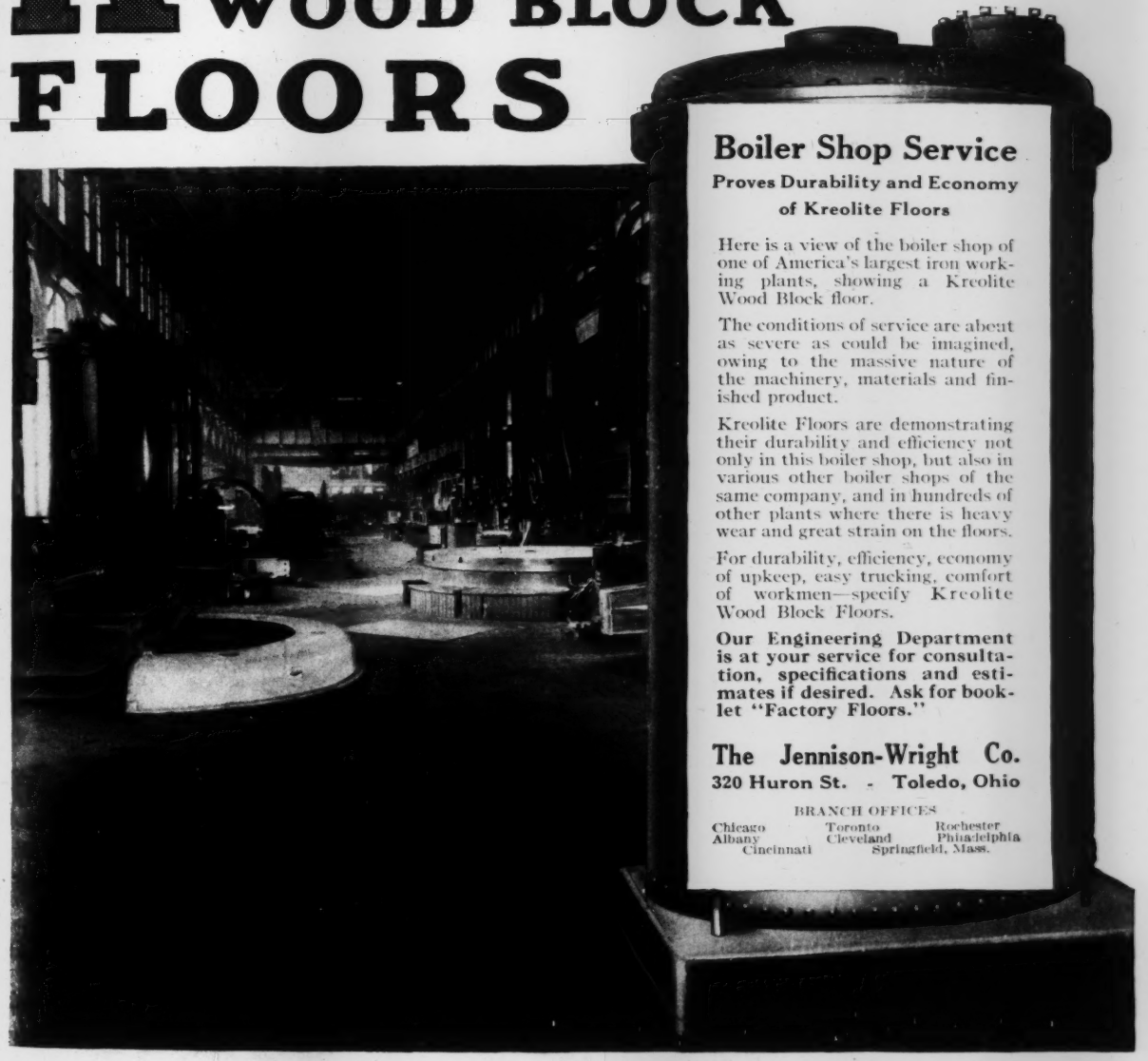
WOOD BLOCK
FLOORS



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Engineering News

VOLUME 75 MAY 18, 1916 NUMBER 20

Rapid Tunneling in Brazil

By J. C. Balcomb*

SYNOPSIS—A 5¼-mi. tunnel was built at top speed to bring water to the Lages reservoir of the Rio de Janeiro Tramway, Light and Power Co. A length of 27,657 ft. was completed in 489 days; the best single-face monthly record was 512 ft. A large advance heading, 13x8 ft., was driven. Five drills were mounted on a horizontal column and moved with a tunnel carriage. Mucking and drilling went on together. Twenty holes were shot in rotation by using varying lengths of fuse. Bonus system of wages helped speed; Spanish labor preferred to native or North American.

Pirahy tunnel in Brazil for years will be a topic of live engineering interest, both because of its construction and its use. Its 27,657 ft. of length was finished from portal to portal in 489 days, and the best single-face monthly record was 512 ft. Conditions at all times were subordinated to speed, and this brought unusual handling of labor and equipment.

The City of Rio de Janeiro, with a population of over 1,000,000, is supplied with all electricity for light, power and city transportation by the Rio de Janeiro Tramway, Light and Power Co., Ltd., a Canadian corporation. The principal power-generating station is located about 50 mi. west of the city, at Lages, and is designed for a maximum output of 50,000 kw. This is a hydro-electric plant, operating under a 1,000-ft. head (see *Engineering News*, July 17, 1913) and drawing its water-supply from a reservoir of some 6,777,600,000-cu.ft. available capacity.

The project was constructed during the comparatively wet years of 1905-07, and there never was any shortage of water apparent until about 1910. Then, owing to the unprecedented demand for electricity in the city and to a succession of dry years, the water level in the reservoir became very low, and an auxiliary steam plant had to be built in Rio de Janeiro. As the coal bill to operate this amounted to several thousand dollars per day, some additional water-supply became imperative, and the 5¼-mi. Pirahy tunnel was designed and bored to divert the water of the Pirahy River into the Lages storage reservoir.

FIG. 1. DISCHARGE FROM PIRAHY TUNNEL, LAGES POWER DEVELOPMENT, BRAZIL

Since the completion of this tunnel not a pound of coal has been consumed at the steam plant.

The tunnel was bored under three hills, as shown on the accompanying profile, the two end elevations being divides and the center one a round knob. The work was attacked at ten faces by means of four shafts and two portals. One shaft was located very close to the outlet end; therefore, the progress was actually made from eight working faces.

*Pearson Engineering Corporation, 115 Broadway, New York City.

Construction began on approach cuts Nov. 1, 1911, and water was turned into the tunnel on Sept. 28, 1913, an interval of not quite 23 months. The advance heading, 13 ft. wide by 8 ft. high, was probably one of the largest ever driven. It was justified by the expectation that water would be demanded as soon as the headings met, so that as great an area as possible was desirable, and it was so planned that stoping might be delayed until the demand for water was less urgent. For speed the Swiss system of tunneling in hard rock was adopted—namely, a bottom heading and short rounds thrown well back from the face with plenty of powder in order to facilitate mucking. The times of the several tunneling operations are shown by Table 1.

The rock in about 90% of the tunnel was solid gray gneiss of constantly changing character and very seamy and fractious; the rest of the material was either decomposed trap, necessitating timbering, or strata of extremely hard diabase. Only about 1,000 ft. of the tunnel had to be lined. Water was struck in every advance, and pumps were maintained at all shafts and the upper portal end.

Five Ingersoll-Rand 3¼-in. piston drills were used in each face, and it was the endeavor to supply them with air at 95 to 105 lb. The first bit was a 2⅝-in., the second 2⅛-in., the third 1⅞-in., the fourth 1⅝. The powder sticks were 1¼x7 in. A great deal of time was lost on account of inability to get spare parts, and the full economy of the machines was seldom realized. These five drills were supported on an 8-in. horizontal column 12 ft. long, which in turn was taken to and removed from the face by a Carter tunnel carriage. This apparatus consists of a small truck supporting a beam that projects to the front over the pile of muck, and a [illegible] to propel the 8-in. horizontal column back and [illegible] along the beam. After a blast the track was cleared [illegible] debris to within about 16 ft. of the face, the carriage was pushed forward as far as possible and the head end of the beam blocked up on the muck pile. The horizontal column that supported the five machines was then run forward to within about 4 ft. of the face and there jacked secure[illegible] to the sidewalls. When firmly in position, it was released from the beam, and the carriage was taken back into the tunnel and stored on a spur track, where it remained out of the way until drilling was completed.

TABLE 1. TIME OF PIRAHY TUNNELING OPERATIONS

General Averages of Faces, Based on 7 Months' Progress

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 43 min.
Drilling	4 hr. 40 min.
Taking down drills	29 min.
Blasting (including loading)	5 min.
Average time between shots	7 hr. 41 min.

The number of men actually employed at the working face averaged about as follows: 1 face foreman, 1 muck foreman, 6 drill runners, 6 drill helpers, 22 muckers, 1 extra drill runner and helper to insure full service of machines every shift. Muckers include car pushers and laborers pulling back rock from face. Labor mostly Spanish; three 8-hr. working shifts.

Averages Based on Best Week's Work (Pinheiro, Apr. 16-22)

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 8 min.
Drilling	3 hr. 46 min.
Taking down drills	14 min.
Blasting (including loading)	33 min.
Number of holes	20
Depth of holes	1.5 m.
Dynamite, 92% blasting gelatin	39 sticks
Dynamite, 62% gelignite	138 sticks
Average time between shots	5 hr. 41 min.
Total advance (7 days 2½ hr.)	41 m. = 134½ ft.
Average daily advance	5.77 m. = 18.93 ft.
Average advance per shot	1.37 m. = 4.49 ft.
Number of blasts in week	30
Dynamite per cubic meter	8.4 lb. = 6.48 lb. per cu.yd.
Material	Uniform gray gneiss, flat roof—no timber

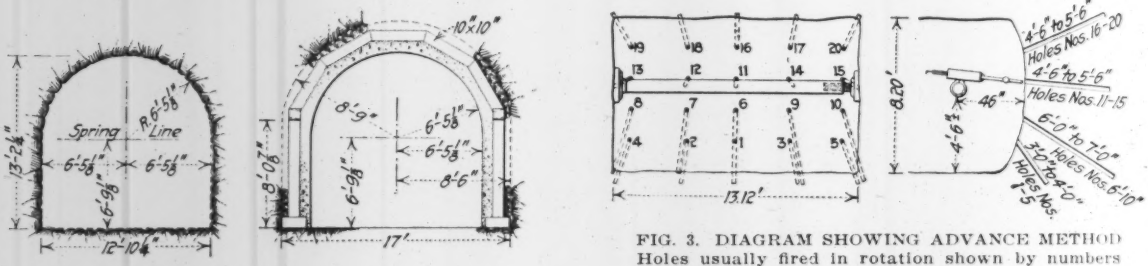


FIG. 3. DIAGRAM SHOWING ADVANCE METHOD
Holes usually fired in rotation shown by numbers

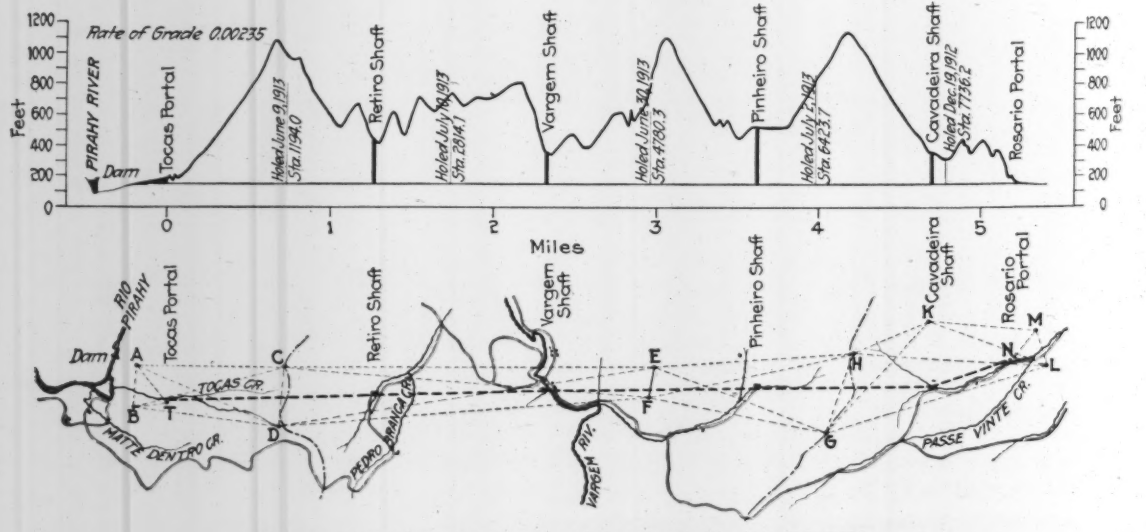


FIG. 2. PLAN, PROFILE AND SECTIONS OF PIRAHY TUNNEL

FIG. 4. INTERIOR OF PIRAHY TUNNEL

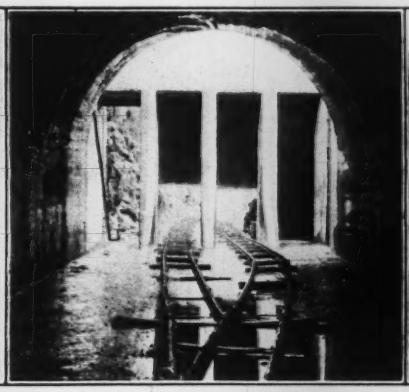


FIG. 5. TUNNEL AT INLET GATES

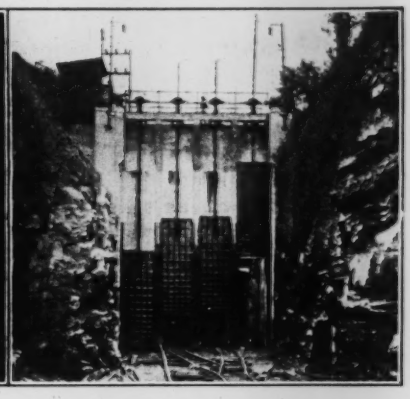


FIG. 6. TUNNEL ENTRANCE AND GATES

The advantages derived from the use of the tunnel carriage were that it saved the time necessary to muck back from the face for vertical columns; it saved the men the heavy lifting and tugging of the drills and vertical columns over the muck; and it gave the muckers a clear space to muck out under the column, as the drill runners could stand upon it to crank their machines. The method of drilling, the depth and position of drill holes and the rotation of shooting are shown in Fig. 3.

Unusual Blasting Methods

After the completion of drilling, the holes were cleaned with compressed air by a nozzle on the air hose and afterward nearly filled with gelignite, or blasting gelatin, ranging in strength from 62% to 92%. Very little tamping was done other than stuffing in a few pieces of dampened cardboard that came wrapped around the powder. Only the very highest grade of fuse, every foot of which was guaranteed by the manufacturers to be X-rayed, was used; this was cut into equal lengths and properly prepared with detonators, etc., above ground. (No. 8 detonators were used exclusively after numerous failures with No. 4 and No. 6.)

When the holes were all loaded and the fuse tamped in, the round was made ready to fire in the following manner: The five top fuses in holes Nos. 16 to 20 inclusive (Fig. 3) were left full length; beginning with No. 15 a short length was cut off, and the length of the piece thus cut was gradually increased in each succeeding hole until the first hole to be shot (No. 1) remained with the shortest fuse. A foreman would then peel back the paper on a stick of gelignite, ignite it and use it to "spit" the fuses, beginning with hole No. 1 and finishing with any one of the top holes.

The deliberation with which the Spanish foremen performed this task was almost uncanny; but it was very successful, as it left a distinct interval between each shot and the workmen soon learned to locate the missed hole accurately by a too long lapse of time. A second shot to clear away a bump left by a missed fire was rarely necessary; it usually saved much time to wait and remove these later with Jackhamers and light shots from behind. The men became expert at this style of shooting, and a great deal of the speed attained was attributable to the system. Such a method is contrary to almost any state law in the United States as being too dangerous, but its justification in this case lies in the fact that in the thousands of rounds fired by this method on the Pirahy tunnel there was not a single accident from that cause. After the round had been fired and a reasonable time had been allowed for any missed shots (but without waiting for smoke to clear), the machine runners and helpers went in to bar down the roof and clear the face, while the muckers followed and cleared the track for the tunnel carriage.

As in most tunnels, the progress was limited principally by the ability to get the muck out of the way. To hasten this work, the double-shift system was used. The muck car was brought in by car pushers, and the box was thrown to one side of the track and the truck to the other, a little way back of the face. The resting shift kept an eye on the loaders at the front, and when their car was nearly full, the former got ready to throw truck and car body on the track as soon as the loaded car was pushed by. Very little time thus elapsed when cars were not being actually loaded.

During a record week, cars were loaded and taken out at the rate of a car every 4 min.; the general average under fair conditions was about 6½ to 7 min. to each. Under ordinary circumstances it was found that by keeping plenty of men to rake back the muck from the front and under the column the muckers could get the material out of the way and do all necessary track laying as soon as the drilling was finished and be ready to help the machinemen take down the column, etc. The speed attained by using the foregoing method of drilling, shooting and mucking is shown in Table 2 on p. 925.

Bonus System of Wages

To encourage the men to take a personal interest in the progress, a unique bonus system was adopted. A minimum month's work was made 75 lin.m., and the bonus began above that figure; for every meter in excess of 75 m. and up to 90 m. the men were given 75 milreis, or about $24.20, per lineal meter. For everything over 90 m. a month, 150 milreis, or about $48.40, per meter was granted. In the record month there was distributed something over $3,550 among 135 men at one face. This bonus was distributed to the men in proportion to the wages received by them at the end of the month. All men known as "smoke eaters," who actually did the hard and sometimes dangerous work at the face, participated in this bonus in proportion to the full amount of their wages; other men helping the progress more indirectly, such as car pushers, cage tenders, steel sharpeners, etc., shared in the bonus in a proportion of from one-quarter to one-half of their wages, the idea being not only to make it an object for the best men to strive to get to the most

essential part of the work, but to keep all men interested in the progress. Probably one of the greatest advantages of this bonus was that it automatically kept the gangs at a minimum number—the more men the less bonus to each and *vice versa*. Also, the men themselves made it convenient for a loafer to quit.

This bonus system worked splendidly throughout the job, and more than any other one thing it was responsible for the great progress made. The disadvantage of this plan, as of any other bonus system, was that it tended to make the men careless, safety and all other considerations being neglected to gain a few meters. The foremen in all instances had to see personally that the men barred down the roof properly and took no unnecessary chances.

Labor and Cost Data

During the first eight months or more of the work it was endeavored to do the heavy labor with native Brazilians. This idea, however, had to be abandoned, as the natives had not the inclination, the strength or the intelligence to work as hard and steadily as was required. Even the inducement of higher wages than ever before paid in that country failed to attract any men who could run drills or do ordinary tunnel work, until foreigners (principally Spaniards, but with some Portuguese and Italians) were finally secured. If comparisons are made with other tunnel records, it should be borne in mind that on the Pirahy tunnel all men were green hands when hired; all machine runners, helpers, muckers, powdermen, tool sharpeners, etc., learned the business on the job. It is reasonable to assume that, had this organization on the completion of this tunnel been shifted to another and similar piece of work, the progress would have been considerably more rapid. While the natives made poor tunnel labor, fair blacksmiths, mechanics and roustabouts were recruited from among them. The organization built up gradually became as fine a body of laborers as the writer has ever seen in any country. The wages paid averaged about as follows:

Face foremen		$3.26 for 8 hr.
Muck bosses		2.90 for 8 hr.
Machine runners	2.26 to	2.43 for 8 hr.
Machine helpers	1.80 to	1.94 for 8 hr.
Muckers	1.45 to	1.80 for 8 hr.
Other inside labor	1.29 to	1.45 for 8 hr.
Timbermen	1.60 to	2.60 for 10 hr.
Blacksmiths	2.60 to	3.26 for 12 hr.
Blacksmiths' helpers	1.45 to	1.94 for 12 hr.
Mechanics	1.45 to	2.42 for 10 hr.
Roustabouts	.97 to	1.29 for 10 hr.

These wages, except for roustabouts, are probably 25% higher than the average paid in that country. Men were paid with Brazilian milreis, and the wage list given is calculated with exchange at $3\frac{1}{16}$ milreis to the dollar, the average rate before the war.

Advance (based on a seven months' average period):

	Per Cu.M.	Per Cu.Yd.
Labor	$7.77	$5.92
Bonus	.97	.74
Powder* and fuse	3.11	2.37
Total	$11.85	$9.03

Stoping (based on progress of August, 1913):

	Per Cu.M.	Per Cu.Yd.
Labor	$4.21	$3.21
Bonus	1.05	.80
Powder† and fuse	1.35	1.03
Total	$6.61	$5.04

*Powder used in advance, 9.04 lb. per cu.m. and 6.90 lb. per cu.yd. †Powder used in stoping, 4.49 lb. per cu.m. and 3.43 lb. per cu.yd.

The cost of labor (actually employed in tunneling operations), powder and bonus, per cubic yard of tunneling in hard rock, was about as shown above (powder—of English manufacture—cost, laid down on the work about 30c. per pound). If economy, rather than mere speed, had been of prime importance, the figures herewith could have been shaded a third or more.

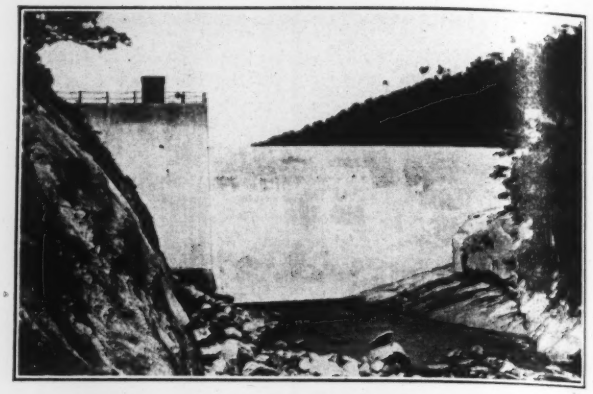


FIG. 7. PIRAHY DAM FROM DOWNSTREAM SIDE.

It may be interesting to mention here that 200 tunnel laborers and their foremen from the New York subway work were sent down to the Pirahy tunnel to show the Spaniards "how to do it." Most of the Americans turned round and went back north on the same boat that they arrived on. The few who remained were disinclined to work with the horizontal column and preferred the vertical-column method, where the face must be cleared first, losing much time thereby; they refused to use any but electric exploders in blasting and would not go into the smoke like the Spaniards. Furthermore, the American machine runners would not help muck back and assist the progress, as did the Spanish machine runners. This experiment decided for us, at any rate, that American laborers cannot or will not successfully put up with labor conditions as they are met with in Brazil.

FIG. 8. VARGEM SHAFT INLET, PIRAHY TUNNEL

After the headings had all met and water had been allowed to run through the tunnel for a few days, it was endeavored to stope during 10 hr. in the daytime and permit the water to run through at night. It was speedily discovered, however, that this was impracticable, as it took several hours for the tunnel to drain, and the proportion of lost time was out of reason. Therefore, the whole force was put to stoping 24 hr. a day, using telescopic

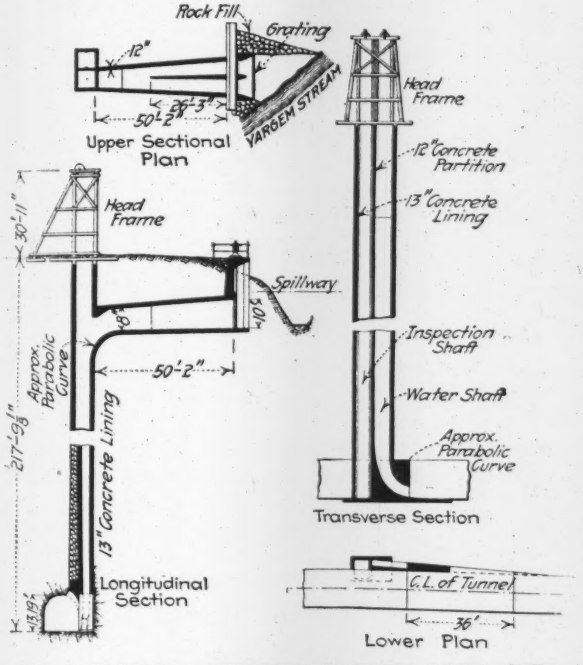


FIG. 9. "SNOUT" DIVERTING VARGEM RIVER INTO PIRAHY TUNNEL

drills for stoping, jackhamers for trimming and 52% gelignite for blasting; the record made is shown in Table 1.

When any timbering was necessary, it was found desirable and economical to import timber for that purpose from the United States. The native lumber was principally hardwood, extremely difficult to tool and too heavy to handle economically, particularly in segment work. The Parana pine from southern Brazil was too brash and totally unfit to withstand any great stress. Therefore, practically all timbering except lagging was done with North American pine.

The country under which the tunnel passes is very broken, and the triangulation system adopted embraced some unique features. No suitable place for a long base line existed except in the bottom of a valley, and to utilize such a location and transfer the measurements to the hilltops involved a secondary triangulation system of no mean proportions. For that reason the base line chosen was put a-straddle of the center hill under which the tunnel passes. This hill is a high round knob, and it afforded room for only a 320-m. base line. Even with this length the two ends were separated by the summit of the hill and invisible from each other. It was accurately measured by the common method of chaining on the slope, taking temperatures and reducing to 60° F. and afterward reducing to the horizontal by means of precise leveling. In one quadrilateral the ends were 320.2 m. and 596.4 m. long, and the sides were 2,682.5 m. and 3,688.2 m. long, while two of the included angles were only 4° 42′ and 4° 58′—proportions which are contrary to the accepted standards of good triangulation. All quadrilaterals were adjusted by an approximation of the method of least squares according to Johnson, and the results were entirely satisfactory.

The greatest chaining difference between any two shafts was 0.66 ft. in a distance of 6,839 ft., and the chaining underground was never checked, it not being considered necessary. The center line overhead was first projected from the triangulation system, which gave the line very close to its correct position; this was afterward trued by repeated plungings of the transit. One shot along this line was over 7,000 ft. long. Had shorter distances been adopted, it would have meant probably 10 or 12 shots instead of one, on account of the broken country; and it was figured that the 10 or 12 shots would introduce a greater aggregate error than the long shot, if it were carefully made under favorable light and weather conditions. This line was transferred to the tunnel below by means of 10-kilo (22-lb.) plumb bobs suspended on piano wire about 11 ft. apart, and the engineers were allowed only one 8-hr. shift at each shaft to perform this work. Every precaution was taken during that short time, and the results attained were very accurate. The maximum miss in alignment was 0.160 ft. and in level 0.181 ft. It was found necessary to use American engineers for any work requiring real skill and some initiative; the European engineers encountered in the country and the native Brazilian engineers were not satisfactory except on ordinary instrument work.

TABLE 2. RECORD OF ENGINEERING CHECKS AND LABOR PERFORMANCES, PIRAHY TUNNEL

	Engineering					Labor on Advance*					Labor Performance—Stope†			
From Shaft or Portal	Distance in Ft., C. to C. of Shafts, or Portal to Shaft Computed	Chained	Differences	Alignment in Ft. Missed	Levels in Ft. Missed	Distance Each Way from Shaft, Ft.	Actual Working Days	Average Advance per Working Day, Lin.Ft.	Greatest Progress, Single Month Distance, Ft.	Average Monthly Progress, Lin.Ft. per Day, Ft.	Distance Each Way from Shaft, Ft.	Total Actual Working Days	Average Stoping per Working Day, Lin.Ft.	Greatest Progress, Single Month Distance, Ft.	Average per Day, Ft.
Tocas	6,687,903	6,688,043	+0.141	0.026	0.043	3,917.3	469.4	8.34	397.7	12.8	3,917.2	96.1	40.7	1,476.4	47.6
Retiro up						2,770.7	325.9	8.50	396.6	13.2	2,770.7	98.1	28.2	1,207.3	39.0
Retiro down	5,650,225	5,650,277	+0.052	0.160	0.038	2,544.6	356.9	7.13	341.2	11.0	2,570.5	61.9	41.5	1,558.4	50.2
Vargem up						3,105.6	365.5	8.50	389.8	13.0	3,079.7	68.1	45.2	1,269.7	41.0
Vargem down	6,839,585	6,838,922	—0.663	0.071	0.003	3,345.1	354.8	9.48	438.0	14.6	3,337.6	77.9	42.8	1,348.4	43.6
Pinheiro up						3,494.4	277.3	12.61	512.5	17.1	3,502.0	57.1	61.4	1,706.0	55.1
Pinheiro down	5,728,222	5,727,001	—1.221	0.019	0.016	1,897.3	249.3	7.61	366.5	11.8	2,698.7	76.1	35.4	856.3	27.6
Cavadeira up						3,831.0	291.7	13.13	504.9	16.3	3,029.5	68.0	44.5	1,532.2	49.5
Cavadeira down	2,751,238	2,751,003	—0.235	0.127	0.081	474.7	30.2	15.7	284.1	15.0	188.8	14.7	12.8	188.6	....
Rosario						2,276.2	289.7	7.86	332.0	11.0	2,562.4	136.0	18.8	511.8	16.4
Totals	27,657,174	27,655,248	—1.927												

* General average, based on actual working days, 9.87 ft. per day. Averages are for each face per day. Greatest single month's record for entire tunnel, April, 1913, 3,133.2 ft. Daily average, 104.3 ft.; this record made from eight working faces. † General average, based on actual working days, 37.04 ft. per day. Averages are for each face per day. Greatest single month's record for entire tunnel, August, 1913, 10,430 ft.; 26 working days—water through for five days—daily average, 401.2 ft.

On completion of the tunnel the engineering department conducted an extensive series of water measurements to determine its capacity. For preliminary estimates of tunnel flow an n value in Kutter's formula of 0.02 had been adopted. Subsequent measurements demonstrated this figure to be much too low, and a value of about 0.03 was determined to be more nearly correct. This would probably prove true in any other unlined tunnel dug in similar rock and of comparatively similar slope and cross-section.

The measurements to determine the flow of water in the tunnel were very careful and quite elaborate, and several measuring instruments were used to check against each other, among them two current meters—one acoustic and one electric—and a pitot tube. Also, to get the velocity of the water through the tunnel, a quantity of aniline dye was thrown in at the inlet end and a note made of the time required for the colored water to pass through the tunnel. Experiments were conducted at the

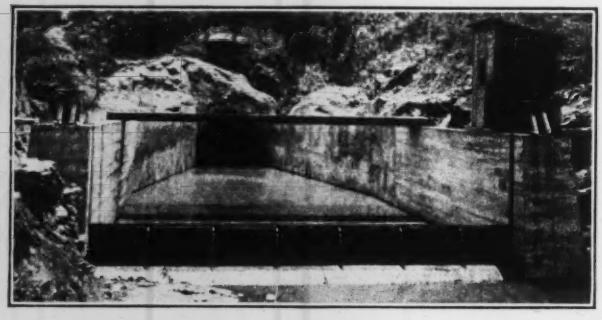


FIG. 10. WEIR AT OUTLET OF PIRAHY TUNNEL

outlet of the tunnel with a salt titration process to determine the flow, but the amount of salt required rendered it impracticable. Finally, a sharp-crested rectangular weir was built just below the outlet of the tunnel, and by means of a recording float gage an accurate record of the tunnel flow was maintained. The n value of 0.03 was deduced from these various measurements.

Allied Works of Pirahy Tunnel

Across the Pirahy River near the inlet of the tunnel was built a concrete dam of the overflow gravity type. This dam was for diversion only, and the construction involved no unusual difficulties except the ever-present problem of transportation of materials in such a country. It impounded practically no storage water. The flow into the tunnel was controlled by four electrically operated rectangular valve gates each 5x16 ft. These are closed only at rare intervals, when inspection of the tunnel is considered necessary.

About midway of the tunnel and traversing the surface is a small stream called the Vargem River. As there was a shaft at this point, it was decided to utilize this water for storage by diverting it into the tunnel by way of the shaft. It is obvious that, were this water dropped perpendicularly down the shaft, the disturbance created at the bottom would have a retarding effect on the main stream passing; it is equally apparent that if the force of water dropping 200 ft. was properly directed and the force expended in the right direction, it should have an accelerating effect upon the main current of water in the tunnel. So with this in view the water from the Vargem was guided into the tunnel at the foot of the shaft by a reinforced-concrete tube colloquially known as the "snout." This was so constructed (Fig. 9) that the falling water was diverted from a vertical to a horizontal flow down the tunnel by an approximate parabolic curve and at the same time thrown sidewise enough to enter the main stream at a small angle (the shaft proper being situated at the side of the tunnel).

It was almost impossible to make any actual observations or calculations of the effect of the entrance of the water at the foot of the shaft, but it was discovered that it was an extremely hard matter to build a floor there which would withstand the heavy impact of the falling water. The writer had himself lowered with ropes into the tunnel stream one time and observed the action for some minutes, and from these and subsequent observations it is believed that the falling water actually assists the velocity of the main stream to some extent when the tunnel is running full, as there is no apparent disturbance. When running only half full, the commotion is so great that there must be some slight retardation.

The tunnel was constructed by administration by the Rio de Janeiro Tramway, Light and Power Co., Ltd., of which W. G. McConnel was Chief Engineer until 1913; the late D. H. Campbell was Superintendent, and to him were primarily due the efficient organization and the splendid progress made. The writer was first Chief Engineer of the tunnel, later Assistant Superintendent and eventually Chief Engineer of the company.

Building Los Angeles Aqueduct Irrigation System

By Burt A. Heinly*

One of the largest development enterprises to be undertaken by a municipality has been actively entered upon in the past few weeks by the City of Los Angeles. This comprises the practical reclamation of over 137 sq.mi. (87,305 acres) by the construction of an irrigation system of 350 mi. of steel pipe lines and approximately 13 mi. of concrete supply conduits. One of the notable features of the task is that practically the whole works will be constructed without the use of the horse—mechanical equipment having taken his place. The building of the system follows as a consequence of the construction of the Los Angeles aqueduct, which will comprise the collection and storage works of the system. The engineering design of the irrigation system was described in detail in *Engineering News,* Feb. 18, 1915. This article will therefore be devoted to the plans for the consummation of the enterprise with a forecast of the plans in embryo that are now being developed for the additional use of surplus aqueduct water.

The land at present to be irrigated was annexed to Los Angeles in the early summer of 1915 for the sole purpose of giving the city the exclusive jurisdiction and management of the water-supply, the further provision being exacted of the territory that it should mortgage itself for the installation of the distribution system. The larger part of the valley (76,090 acres) did this in 1915 by voting a bond issue of $2,606,000. The remaining district (the Mission, 11,215 acres) accomplished the same purpose on Mar. 23, 1916, by voting a bond issue

*City Water Department, 645 South Olive St., Los Angeles, Calif.

of $390,000. This makes the total amount available $2,996,000, or a cost per acre of $34.44. In addition, the municipality will expend an estimated $1,496,959 for conduits and reservoirs which will be used for irrigation demands, but which are primarily designed to provide regulation and storage of the aqueduct flow in its development of hydro-electric energy. The total planned expenditures on this system are therefore $4,449,959. To this must be added a further large but unestimated sum raised by frontage assessment where property owners to procure the water must carry it at private expense from the bonded laterals, which are spaced ½ mi. apart.

Money from the sale of bonds was not available until January of this year, so that instead of purchases of steel in a depressed market, as was hoped for, the city has thus far found itself in a position where it was required to purchase in an inflated market. The total estimated requirements for construction are 25,000 tons. Estimates based on Los Angeles water-works costs provided for building the works at a cost of 5c. per lb. for the steel in the ground plus 2½% for gates and fittings and 10% for engineering and all other incidental expense. This estimate was considered fair, but yet ample to cover contingencies. A review of the figures on contracts recently awarded will show the very narrow margin left for installation.

The first specifications called for the delivery of 4,097 tons of 8- to 54-in. pipe, delivered trench-side in 23-ft. lengths with rivets for field riveting where necessary. Bids were opened Dec. 28 and the contracts awarded to two local bidders; 2,456 tons at 3.29c. per lb. and 1,350 tons at 3.805c. per lb. Again on Feb. 23, bids were opened for 6,500 tons, but with the exception of a single item the prices asked ranged from 5½ to 6¾c. per lb. The one item was for 2,725 tons of sizes ranging from 8 to 18 in. at a price of 4.477c. per lb., with delivery completed in 210 days. Bids were rejected on all but the last item, which with the January contracts will keep the work going until about the first of next year. This will give opportunity to see whether by the improved methods of laying that have been planned the advanced price of materials can be counterbalanced.

All pipe of sizes up to and including 20 in. will be of field-driven joints. For the small sizes the trenching will be by trench excavators, three of which are now on the ground and two of which began operations Apr. 10. Trunk-line trench will be excavated by Marion Model 40 shovels, equipped with extra-long booms, of which the department has four ready for service. Backfilling will be with backfilling machines. Transportation of men and materials will be in 2½-ton 37-hp. motor trucks, with extra-long armored bodies built for the purpose in the department's shops.

On conduit construction, fortunately, war conditions offer no interference. One of the two concrete gravity supply lines has been under construction since the first of the year, and the 4,500 ft. of tunnel comprising one of the classifications will be excavated by May 1. The whole line, with a length of 6 mi. and a delivery capacity at the inlet of 7,500 miners' inches, will be ready for operation by June 1, or in time for the present irrigation season. The other line, the Chatsworth conduit, comprising 4,320 ft. of tunnel and 35,122 ft. of lined conduit, was started on Apr. 11, but cannot be completed and placed in operation this summer.

Happily, one of the main trunk lines for the valley is that which was constructed in 1913 and furnishes the City of Los Angeles with its domestic supply. The steel contracts now let provide for the installation of the laterals leading from this line, and many thousands of acres will be irrigated from this source this season. As these extend out at ½-mi. intervals and serve to ¼ mi. on each side, they provide water for each 40-acre tract. Where subdivisions have taken place into from 1- to 10-acre tracts, smaller laterals are run off at right angles so that the whole area will in time be gridironed. The city, for these laterals, makes a charge of 20c. per front foot—that is, 40c. per straight foot of pipe—and installs a 6-in. diameter No. 14 steel pipe. This charge at present cost of steel barely, if indeed, covers the cost. The system, being under heavy pressure—from 10 to 200 lb.—provides for domestic supply as well as for irrigation. On the former, meters are installed and maintained at the cost of the department; on the latter, weirs or portable meters will be employed.

As has been the rule in the past, the construction of the works, including the feeding of the men, is being undertaken by day labor under the direction of the engineers of the City Water Department.

When the system was first projected, its designer estimated that 20 years would be required for the full operation of the works; today it is confidently believed that the whole valley will be under irrigation shortly after the completion of the pipe lines, estimated at from 2 to 2½ years. Last season, 6,500 acres was under the water; this season, when it was foreseen that demands for steel in the East would make impossible satisfactory deliveries on the Pacific Coast, the irrigators formed associations and at their own expense built 7 mi. of flumes and 11 mi. of temporary ditches. There will therefore be under cultivation approximately 30,000 acres of land this season, much of which has heretofore been uncultivated or at best produced a single crop under dry-farming methods. In the construction of the aqueduct the municipality of Los Angeles has probably no counterpart among American or foreign cities for ambitious economic achievement. Entirely aside from the revenues accruing from the sales of water the present season demonstrates the almost incalculable indirect benefits already beginning to be realized from the creation of agricultural and horticultural wealth within the city's borders.

To further extend the use of aqueduct surplus water, there will shortly be placed before the voters the additional annexation of about 30,000 acres. This territory stretches away from Los Angeles to the sea on the southwest. Much of the area includes the Santa Monica Mountains, the western slopes of which it is proposed to water. The land is fertile, but at present for the most part waterless. With a supply from the aqueduct and cooled by the breezes of the Pacific, its slopes, valleys and tablelands comprise the most ideal estate and villa property in America. Following its annexation, Los Angeles will be in a position to form a territory of a single city and county government, the boundary lines being determined by the area that may be supplied from the aqueduct's flow. The plan is one of very far-seeing municipal construction in preparation for the economic handling of a large and dense population, primarily agricultural and horticultural, but essentially urban after a lapse of perhaps not many years.

Building Concrete Lighthouse on Brandywine Shoal

By T. J. Rout*

SYNOPSIS—Details of design and construction of a reinforced-concrete lighthouse to replace 60-year-old iron lighthouse in Delaware Bay. Concrete foundation caisson made on shore and towed to site. Concrete superstructure built from working platforms on and alongside old lighthouse.

Brandywine Shoal is about 2½ mi. long, running parallel with the main ship channel of Delaware Bay and is 11½ mi. north of Lewes, Del. At this point the bay is 16 mi. wide and the site has little protection against storms. The nearest harbor is at Lewes, and the nearest land is at Cape May, 7 mi. distant, the Delaware shore of the bay being 9 mi. away. The site has a submerged depth of 8 ft. at mean low water, and the tides have a mean rise and fall of 6 ft., with a current velocity of 3½ mi. per hr. The original structure on the site was an iron-frame lighthouse on screw-piles, erected in 1850 at a cost of $53,000 and the first of its type in the United States. The wrought-iron piles had deteriorated to such an extent that it became advisable to build a new structure near-by rather than to attempt repairs. Accordingly, in 1911 Congress appropriated $75,000 for a new lighthouse. Work was started in 1912 and completed in 1914. A one-year guarantee by the contractor expired in October, 1915.

Preliminary test borings made at the site showed very hard sand to a depth of 60 ft., and then a hard blue mud for 10 ft. more, the extent of the borings. For this condition a design was prepared consisting of a pneumatic caisson foundation 35 ft. in diameter and 37½ ft. high, built of 1¼-in. cast-iron plates, the whole supporting a cast-iron superstructure. At the first letting no bids for the complete structure were received. Bids were again invited under the same plans and specifications, but it was stated that due consideration would be given to proposals for a reinforced-concrete structure, the bidder to furnish detailed plans and specifications.

Two bids for a complete structure were received, one from the Phœnix Construction Co. in the sum of $175,000 for an iron structure, and the other from the Interstate Construction Co., of Mobile, Ala., for a reinforced-concrete structure, in the sum of $69,850 for the lighthouse and $2,500 for 900 tons of riprap to be placed around the foundation to prevent scour. This latter bid was accepted, and a contract was entered into to cover the work. It provided for partial payments and contained a clause that the contractor must guarantee the structure for a period of one year after its completion and acceptance by the Government.

As shown in the details in Fig. 2, the lighthouse is a cylindrical structure with a footing section of a cellular caisson cast on shore and floated into place, where it was bedded on timber piles and pinned to place with concrete piles. The superstructure, of decreasing circular sections, is of reinforced concrete built in place. It consists of a 3-story circular concrete dwelling, 26 ft. in diameter, supporting a circular watchroom and a standard third-order lantern. The circular walls of the superstructure are 6 in. thick, reinforced with ½-in. rods, 12 in. c. to c. in both directions.

The first floor consists of a 5-in. slab reinforced in both directions by ½-in. rods and supported on eight radial 14x22-in. beams. At this level a balcony extends entirely around the lighthouse. The balcony floor is supported on sixteen 12-in. brackets, while its roof is supported by sixteen 6x6-in. concrete columns. The upper floors consist of a 6½-in. slab reinforced in both directions by ½-in. rods. All were designed to carry a live-load of 200 lb. per sq.ft. together with the dead-load. There is a balcony with iron railing at the level of the third and lantern floor.

The balcony floor slabs were covered with a three-ply tar and felt roofing, and this waterproofing was covered with a 2½-in. layer of cement mortar. The inside floors were finished with a ½-in. coat of asbestos composition flooring. Room is provided for the lantern and foghorn machinery in the basement, and quarters for three men are in the upper stories.

Building and Placing the Foundation

The concrete foundation shell (35 ft. in diameter and 18½ ft. high) was erected on a launchway on the beach at Lewes, Del. It contained 104 cu.yd. of 1:2:3 con-

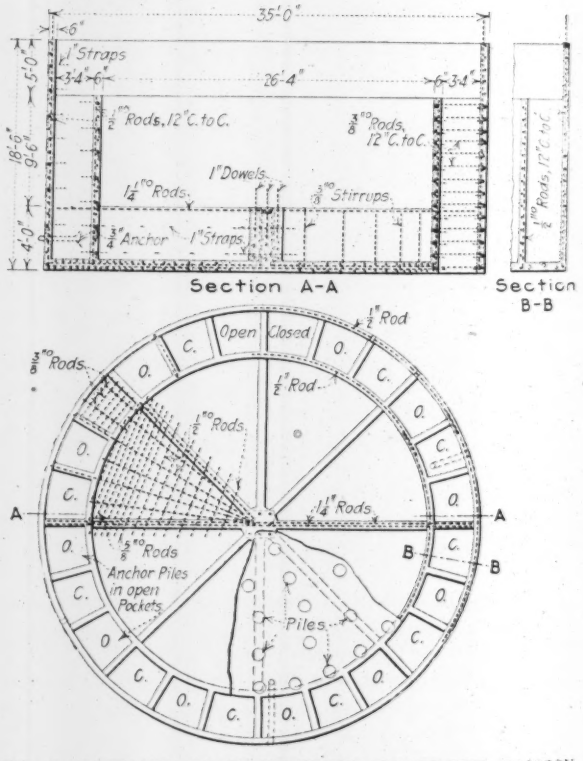


FIG. 1. DETAILS OF REINFORCED-CONCRETE CAISSON FOUNDATION FOR BRANDYWINE SHOAL LIGHTHOUSE

*United States Lighthouse Inspector, Philadelphia, Penn.

crete, 11,400 lb. of steel reinforcement and weighed about 225 tons. Details are shown in Fig. 1. The shell consisted of circular inner and outer walls, each 6-in. thick spaced 3 ft. 4 in. apart. An 8-in. concrete floor extended to the inner circular wall only. This floor was reinforced on the upper side by eight 10-in. by 3 ft. 4 in. radial beams. The outer and inner circular walls were joined together by twenty-four 6-in. radial partitions. Each alternate pocket thus formed was sealed at the bottom with an 8-in. floor, the other pockets remaining open. The reinforcement for the bottom consisted of two layers of plain iron rods ½ in. to ⅝ in. in diameter, spaced 6 in. to 12 in. on centers. The walls were reinforced by vertical and horizontal ½-in. rods, 12 in. on centers. The forms were of 7/8x8-in. horizontal boards, well nailed to 1x4 in. upright studs, spaced about 22 in. on centers.

While the concrete work was in progress on the shore, a working platform was erected by the contractor at the site to accommodate the storage of materials and to facilitate the work. It was supported on 35 piles driven 7 ft. into the sand. Its deck was 1,100 sq. ft. in area and was 9½ ft. above mean high water (Fig. 5). In addition to this, the contractor was allowed to use the platform around the old lighthouse. On this was erected the quarters for workmen, the hoisting engine, pumps, water tanks, concrete materials, etc.

After these preliminaries 74 pine bearing piles were driven at the site. Each pile was calculated to carry about 20 tons, had a penetration of 20 ft. and terminated 1 ft. above the top of shoal. The greatest number of piles put down in one day of 8 hr. was 20. All were driven by means of a jet, the water being supplied through a 2-in. hole reduced to a ¾-in. nozzle and furnished under high pressure by a duplex piston pump provided with its own boiler. The pump had a normal capacity of 600 gal. per min., but it was not necessary except on rare occasions to work it to the limit. A 2-in. pipe was screwed about 5 in. into the head of each pile to guide it and hold it in a vertical position. By means of an engineer's level and a file mark on the 2-in. pipe, the elevation of the top of the pile could be determined. In this manner the piles were jetted to the exact depth required, thus eliminating the services of divers. Near the center of the foundation, when the piles were close together, it was found that in jetting one pile down, another would rise. This trouble was overcome by lashing the 2-in. pipe follower to the falsework.

When the foundation had been prepared the shell was launched at Lewes in the same manner as a vessel. On account of a sand shoal, it struck on the bottom in 5 ft. of water at low tide, and it was necessary to dredge a cut in order to float it. Before the shell was launched, the open pockets were floored with 2-in. planking to exclude the water. In launching three of these were damaged and allowed the water to come in. This gave the shell quite a list. Much delay was experienced in securing a tug to tow the shell to the site, and some anxiety was felt lest a storm should damage it while anchored about 750 ft. from the shore and near the wharf. Water did not seep in to any extent.

A tug, by means of a 13-in. hawser towed the shell to its destination. It weighed about 225 tons, had a draft of 9 ft. 2 in. and a free board of 9 ft. 4 in. It was towed around the west end of the inner (or old) Delaware Breakwater, thence to the eastward around the south end of the outer breakwater, thence northward to the site. The total distance traveled was 14 mi., which was covered in 4 hr. For the first 3 mi. the towing was against the tide and

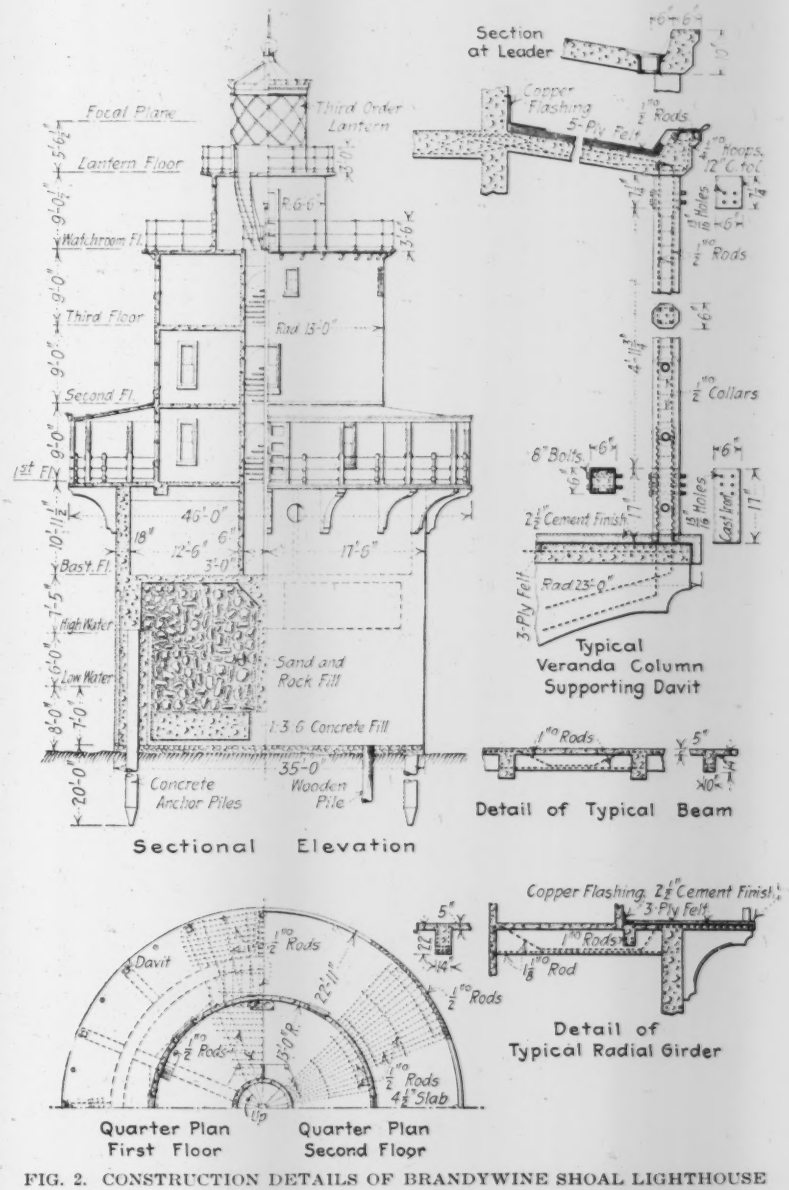
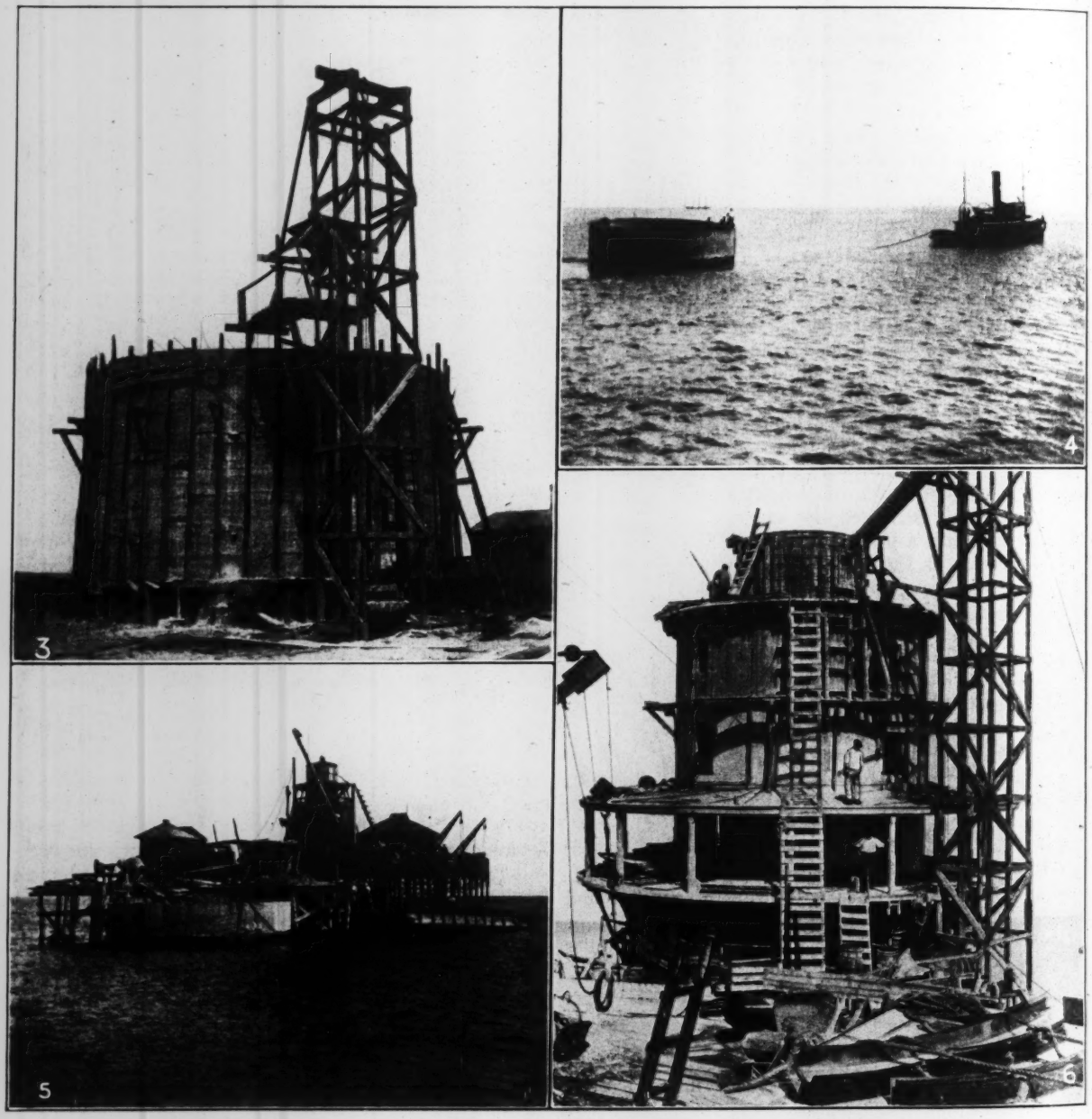


FIG. 2. CONSTRUCTION DETAILS OF BRANDYWINE SHOAL LIGHTHOUSE

slow progress was made, but after passing the outer breakwater, better speed was maintained on account of flood tide. There was a slight swell on, and at times the shell had a freeboard of only 7 ft. (Fig. 4). However, no water came inside it.

At high-water-slack the shell was floated into place and sunk upon its pile foundation by means of sea-cocks. To pin the structure down, twelve 16x16-in. concrete anchor piles, 34 ft. long, were driven in place through the open pockets. Each of these piles had a penetration of 20 ft. into the sand, weighed about 4½ tons and was calculated to carry 55 tons. They were put in place by means of two water jets. After the piles were in place, the bottoms of the pockets were sealed by depositing concrete in bags. The water was then pumped out, and the pockets were filled with concrete deposited in air. Concrete was also deposited in the closed pockets; after this the water was pumped out of the foundation and the space up to the tops of the radial beam was filled with concrete. Above this level and up to the basement floor excepting the water tank, the fill consisted of sand and stone.

The 12 anchor piles made of 1:1½:3 concrete were cast on shore. The reinforcement consisted of a ¾-in. rod in each corner. The forms for two piles were erected parallel with each other and 16 in. apart. These piles were poured, the forms were then removed, the sides of the two piles well greased and a third pile was poured in the space between the other two. Three others were made in the same manner on top of the lower three. The lower end of each pile was pointed, and the upper end was



FIGS. 3 TO 6. VIEWS OF BRANDYWINE SHOAL LIGHTHOUSE DURING CONSTRUCTION

Fig. 3—Building the foundation caisson. Fig. 4—Towing the caisson to the site. Fig. 5—Work in progress, showing foundation caisson, working platform and old lighthouse. Fig. 6—The superstructure under construction

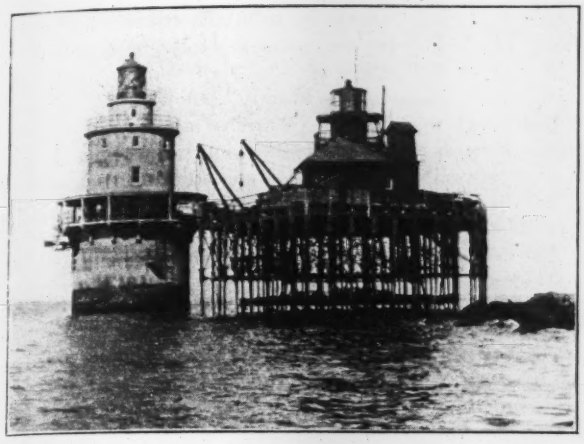


FIG. 7. THE NEW AND OLD BRANDYWINE SHOAL LIGHTHOUSES

provided with a heavy iron ring for handling purposes. After the foundation was made secure at the site in November, operations were suspended for the winter. The work was resumed the next May. The summer was devoted to the construction of the upper works. All material had to be brought in by barge and stored to the extent possible on the working platform and old lighthouse. Fresh water was used in mixing the concrete, and had also to be brought out from shore. The view in Fig. 6 shows the progress of this superstructure work, which was carried on in accordance with approved standards of reinforced-concrete framework.

Subsequent to the structural work, a 3-ft. layer of riprap was placed around the foundation as a protection against scouring.

The lighthouse is the first one of its kind in the United States located on a submarine site. Although the idea was novel, the success of the work justified the acceptance of the design, and it has demonstrated the suitability of this form of construction for open-sea lighthouse work. In this instance the structure not only was completed for a less sum than would have been required for a corresponding lighthouse of iron, but is lighter, was more rapidly built and will not cost as much to maintain. The storms since its erection have been abnormally heavy and submitted the structure to exceptional strains and stresses, which it withstood with success.

The work was done under the direction of the Lighthouse Service of the United States Department of Commerce.

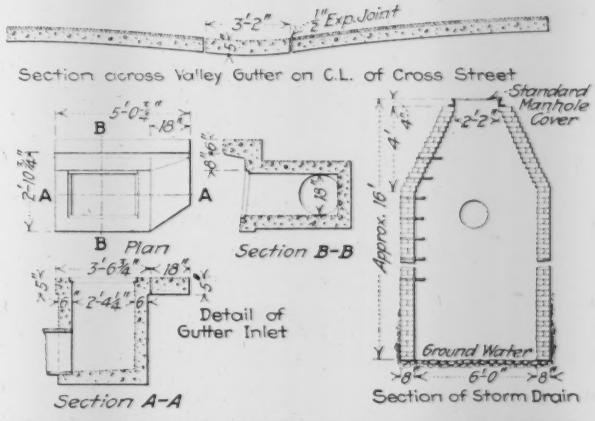
Storm-Water Drainage Sinks at Phoenix, Ariz.

A unique system of storm-water sewerage is being put into practice in Phœnix, Ariz. Instead of installing an elaborate system of storm sewers originally planned to cost half a million dollars the present city engineer, James B. Girand, has made use of some experience acquired in solving a mine-drainage problem in the Yuma desert and has adopted a system of drainage requiring no conduits. The storm water from gutters and catchbasins is led directly into bottomless manholes or sumps, where it runs out into the subsoil.

The details of one of these drains and of a curb inlet are shown in the accompanying sketch. Phœnix lies in the Salt River Valley, or more properly, in the old Salt River bed. On top of the upper strata of sand and silt are strata of gravel, through which the groundwater flows very readily. The water table varies in depth from 10 to 16 ft., and it is designed to carry these drains down to approximately this depth.

It has been found by experience practically impossible to flood one of these drains. The contents of a good-sized irrigating ditch have been turned into one for an hour without overflowing the drain. No difficulty has been encountered as yet in the silting up of the bottom, but this of course can be readily cured by scraping off the silt, as any catchbasin would be cleaned.

The scheme was originally adopted because the storm-sewer construction is made a part of pavement work, and it was soon found impossible to have any connected storm-sewer system where only short stretches could be put in from time to time. In this desert country, where the annual rainfall is only 9 or 10 in., the scheme of



STORM-WATER DRAINAGE BY MEANS OF SINK HOLES, PHŒNIX, ARIZ.

drainage adopted in Phœnix seems to offer an ideal solution; so far at least no objections have arisen. The sanitary-sewer system is of course separate.

The older streets have covered culverts to carry storm water past street intersections; but because of the infrequency of rains this provision has been decided unnecessary, and shallow valley gutters of the type illustrated are being used to a considerable extent.

Compression Test for Keel Block—An important test was conducted recently by the United States Bureau of Standards to determine the ultimate strength of a cast-iron keel block. As designed, the block was expected to withstand a load greater than could be exerted by any testing machine in existence. It did withstand the full capacity of the bureau's testing machine (10,000,000 lb.) when the load was applied over the entire bearing surface of the block, but when the load was applied over part of its bearing surface it failed at 9,600,000 lb. The test of the block itself was preceded by several preliminary tests to determine the strength of oak timbers, which are usually placed between keel blocks and the keel of the ship. At loads from 300,000 to 800,000 lb. the timbers were completely shattered, the variation in the load depending entirely upon the variation in the area over which the load was applied. After these preliminary tests the keel block was subjected to a load equal to the capacity of the machine. At about 6,500,000 lb. several sharp reports were heard, but after the full load was applied there was no apparent damage to the exterior of the block. On dismantling it, however, it was noticed that several of the webs of the various sections were cracked. It was then reassembled, and the load applied over a smaller area, when it failed at 9,600,000 lb. with a very loud report and almost complete shattering of the various sections, throwing parts of them a distance of 12 ft.

Activated-Sludge Process on Stockyards Sewage*

By Arthur Lederer†

The Sanitary District of Chicago began experiments with the activated-sludge process of sewage purification on Stockyards and Packingtown sewage in April, 1915. The operation on the fill-and-draw plan was carried on in two galvanized-iron tanks, each holding approximately 200 gal. of sewage. These experiments were continued well into the cold season, being discontinued when the contents of the tanks froze solid. Certain observations were made, which can be explained by the effect of low temperatures upon the process. These observations were substantiated on the larger four-unit installation of the Sanitary District, designed to treat from 30,000 to 100,000 gal. on the continuous-flow basis daily. This installation was put into operation early in 1916, and is under the direction of Langdon Pearse, Division Engineer, and George M. Wisner, Chief Engineer.

The object of this short paper is to elaborate certain facts of a chemical and biologic nature which have presented themselves in the course of operation, and not to furnish any prescription for the treatment of the Stockyards waste. The operation features now being worked out will require much time and experience before a final recommendation can be made. Economically, the continuous-flow process is apparently preferable, but it has certain disadvantages which the fill-and-draw plan avoids. Experience from our experiments and from those of others will probably indicate the solution. As in other sewage-treatment processes, so is this one governed primarily by the composition of the waste handled. The process being largely of a biologic nature is greatly influenced by the temperature of the sewage. In this respect the Stockyards waste lends itself readily to the process, the temperature throughout the entire year varying between 60 and 90° F., at the Center Ave. outlet. The loss in temperature in the plant is only a few degrees in the coldest winter weather. By far the greater percentage of the sewage treated is packinghouse waste. The variation in the day and night flow is extremely marked qualitatively and quantitatively as well. The free-oxygen demand is approximately 8 to 10 times greater than that of the domestic sewage in Chicago.

The changes of the nitrogenous constituents during the aëration process have been carefully studied. Our experience has coincided, so far as I am aware, with the experience of other observers. During the warmer season a reduction of the free ammonia to about 1 or 2 p.p.m., and an increase of the nitrites to 5 or 10 p.p.m., indicate complete oxidation and clarification. This ceased to be the case, however, when colder weather set in with the small galvanized-iron tanks, which were easily affected by changes in temperature in the air. Absolute stabilities were reached in cold days with the free ammonia actually increasing several hundred per cent., and with little, if any, change in the nitrites and nitrates. The reduction of the organic nitrogen was just as marked as in summer. Clarification was very satisfactory. The results I speak of are those noted when the effluent showed a relative stability of 100 or thereabouts. With the small galvanized-iron tanks, in which the warm sewage quickly chilled, it took a considerably longer time in the cold weather to obtain such a high stability, but the chemical results were consistently as noted.

It is clear that in such cases the mechanical features of the process outweighed the biologic features. The highly putrescible colloids have simply been whipped out of suspension by the continuous agitation. Repeated observations indicate that the mere mechanical removal of the colloidal matter from sewage brings about an improvement far out of proportion to the actual percentage of substance removed. There is no doubt, however, that there is some biologic activity even in a liquid near freezing; otherwise, we could hardly account for the persistent increase in free ammonia. We further noted various active protozoa, such as infusoria and trachelomonas, in the sludge at all times. More highly developed animal or plant organisms were not found.

Our work indicates that the temperature of the liquid treated will be a controlling factor. On a large scale temperature changes will probably be much lower than on the very small scale of 200-gal. steel tanks exposed to weather.

During the cold weather we had no ready chemical index to go by, although the regular routine tests of long duration were available. The removal of the colloidal matter was the only immediate indication of accomplished oxidation. This forced us to determine regularly the turbidity of the settled aërated sewage. Used with the methylene-blue putrescibility test, a fairly definite working relation can be established. The tabulation of a large number of results obtained shows that the stability is 100 with turbidities of 10 p.p.m. or less. With a turbidity of 15 p.p.m., the relative stability varies usually between 50 and 100. With turbidities above 15, the quality of the effluent shows rapid deterioration. At turbidities ranging from 20 to 25 the stabilities are usually below 50. To compare turbidities above 25 p.p.m. with stabilities appears unsafe. Such stabilities are without exception very low. The relation spoken of is bound to vary with sewages of different character.

Recently, with the advent of warmer weather, the nitrites are again picking up in the effluent, and no doubt our ammonia index will again serve the purpose. The determination of other constituents, such as the organic nitrogen, albuminoid ammonia, permanganate oxygen consumed, chlorine and the bacterial content are merely of scientific interest. They are not essential for a routine control. This holds good to a certain extent for the dissolved oxygen, but it is quite conceivable that the rate of de-oxygenation at a given temperature can be made to serve as an index of the degree of stabilization accomplished.

The quantity of the settling suspended matter in the final effluent merely indicates the efficiency of the settling process, and has nothing to do with the activated-sludge process proper. Packingtown sewage completely oxidized by the activated-sludge process is clear with a slightly yellow tint, barely noticeable in small bulk.

*A paper read at the meeting of the American Chemical Society, at Urbana, Ill., April, 1916.

†Chemist, Sanitary District of Chicago.

Electrification of the Salt Lake & Los Angeles Ry., in Utah, is to be carried out in connection with an extension of the line. The railway is 15 mi. long, extending from Salt Lake City to Saltair, a resort on Great Salt Lake. H. A. Strauss, consulting engineer, Chicago, has been engaged as engineer for the work.

Pressure of Wet Concrete on the Sides of Column Forms

By A. B. McDaniel* and N. B. Garver†

SYNOPSIS—Tests made on columns built up in laboratory and on posts of a bridge under construction show pressure of wet concrete on sides of forms. Describes methods to measure pressure.

Several investigations have been carried on in the past to determine the lateral pressure exerted by wet concrete on forms, but very little accurate information has been derived.

In 1894 Ernest McCullough made a series of tests in which the pressures were measured by placing a 7/8-in. board in the side of a form and pouring in concrete until the board broke. The pressure obtained was equivalent to that of a liquid weighing about 80 lb. per cu.ft. The weight of the equivalent liquid was probably only about one-half that of the concrete. Owing to the crude manner in which these experiments were conducted, little importance can be attached to the results.

In 1908 a very extensive series of tests, lasting throughout the season, was carried on by Maj. F. R. Shunk, U. S. A., during the construction of the Mississippi River lock No. 1 near Minneapolis, Minn. The tests were made during the pouring of monolithic blocks of concrete 25.75 ft. high. The concrete was very wet and weighed about 152 lb. per cu.ft. The lateral pressure was measured by means of a piston connected to a scale beam. The results indicated that a hydrostatic pressure corresponding to that of a liquid weighing 152 lb. per cu.ft. was obtained at first; but as the head increased, the concrete began to act more as a solid, so that later the pressure remained practically constant. It was also found that the head at which the concrete began to act as a solid varied with the rate of pouring, the temperature, the pressure and the condition of agitation of the surface.

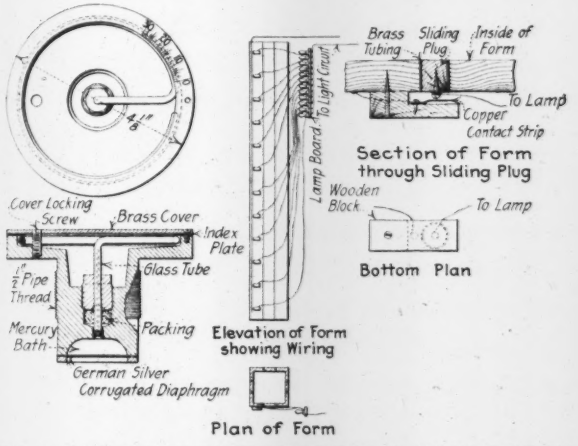


FIG. 1. DETAILS OF GAGE AND METHOD OF INDICATING HEAD OF CONCRETE

In 1913 E. B. Germain, Assistant Engineer for the Aberthaw Construction Co., carried on a series of tests during the construction of a mill building in Cambridge, Mass. A wet 1 : 1½ : 3 mixture was poured at a rapid rate into two columns 20 in. square and 20 ft. high. The gages were hot-water bottles filled with mercury, so that the lateral pressure was measured by reading the level of the mercury in the tubes. A hydrostatic pressure equivalent to that of a liquid weighing from 140 to 150 lb. per cu.ft. was obtained.

University of Illinois Laboratory Tests

Two series of investigations were made during the college years 1913-14 and 1914-15 by undergraduate students of the civil-engineering department, University of Illinois, under the supervision of Professor McDaniel.

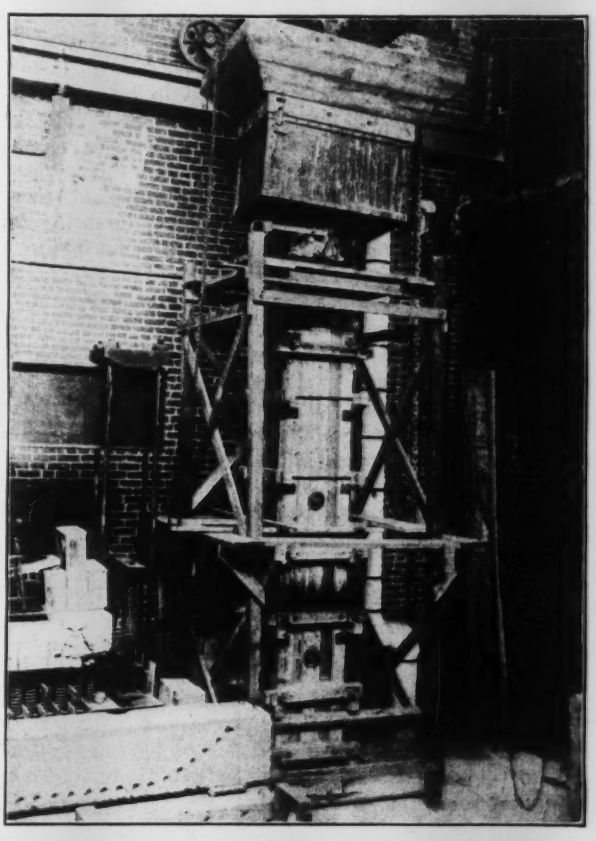


FIG. 2. VIEW OF LABORATORY COLUMN FORM

The tests were made upon two sizes of column forms, and the pressures were measured at five points along the sides of the forms by diaphragm pressure gages.

The tests were made on 12-in. and 20-in. square column forms, the height being 12 ft. in both cases. The forms were made of planks with ship-lap joints and were built of 4-in. interchangeable sections. No trouble was experienced with leakage from the forms (Fig. 2).

The pressure gages were made especially for these tests and were of a type that was successfully used to measure the earth pressures during the construction of the Pennsylvania R.R. tunnels in New York City. Each gage

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†Associate in Civil Engineering, University of Illinois.

(Fig. 1) consisted of a flexible German-silver-diaphragm acting upon a reservoir containing mercury. The pressure was indicated by the position of the mercury in the tube. The graduation of the tube was arbitrary, so that it was necessary to calibrate it. A thick layer of grease covered the diaphragm during the tests, to protect it from temperature changes and small falling particles.

A unique method was employed for determining the height of the concrete in the forms (Fig. 1). Brass tubes were set into the forms at 1-ft. intervals. Wooden plugs fitted with wires and brass screws were set into these tubes. Copper strips wired to electric lamps were fastened over the holes so that the lamps were lighted when the plugs were forced out and made contact. The plugs were kept well oiled so that they would slide easily in the tubes.

A sheet-iron funnel, supported on the top of the tower, directed the concrete from the bottom-dump bucket to the center of the form, which was braced to the tower. The bucket was constructed of sheet steel with a wooden extension and had a total capacity of 48 cu.ft.

The ingredients for the concrete were proportioned by volume. A 1:2:4 mixture of standard cement, glacial sand and crushed limestone was used in all the tests. The concrete was mixed in a ½-yd. batch mixer. For the 12-in. column tests the concrete was mixed in two batches, the first being dumped on the floor and later incorporated with the second batch. For the 20-in. column tests three batches were necessary. The material was dumped from the mixer onto the concrete mixing floor and was then shoveled into the skip. The skip was raised by a traveling crane and moved into position over the column form.

After the concrete was mixed preparatory to the pressure tests, sample cylinders were molded and later tested to determine the crushing strength of the concrete. The average strength of twelve 8x16-in. cylinders was 1,040 lb. per sq.in. at an age of 28 days.

A Bourdon gage was calibrated with a Crosby gage tester and then connected to the end of the gage calibrator to which the pressure gages were attached. The gages were calibrated before each pressure test. The temperatures of the air and the water were taken during each calibration. As soon as the gages were calibrated, they were placed in the form and the test began. Calibration curves were plotted for the readings of the Bourdon and of the pressure gages. These curves were then used to reduce the observed readings of the pressure gages for each test.

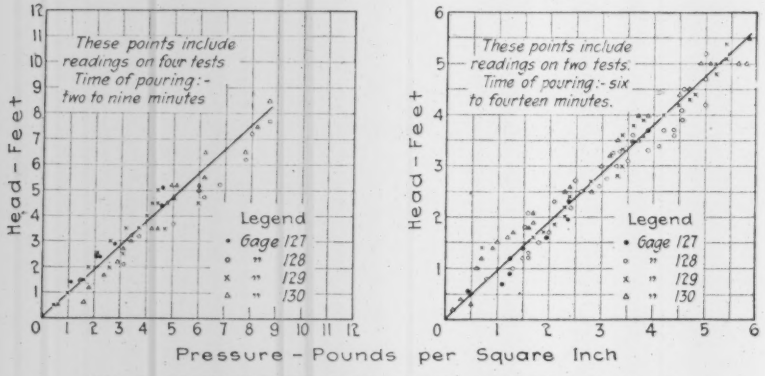
These points include readings on four tests. Time of pouring:- two to nine minutes
Head - Feet
Legend
• Gage 127
○ " 128
× " 129
△ " 130
These points include readings on two tests. Time of pouring:- six to fourteen minutes.
Head - Feet
Legend
• Gage 127
○ " 128
× " 129
△ " 130
Pressure - Pounds per Square Inch

FIG. 3. PRESSURE-HEAD DIAGRAMS ON 12-IN. AND 20-IN. LABORATORY COLUMNS

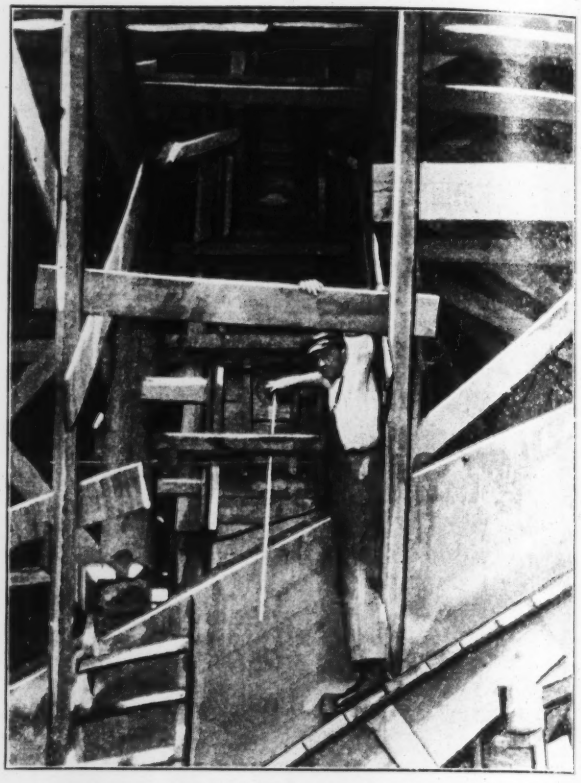

FIG. 4. VIEW OF BRIDGE POST FORM UNDER TEST

The gate of the bucket was opened wide enough to secure a continuous flow of concrete through the hopper into the form. A gong was struck every 15 sec., and the highest pressure reading during the interval was recorded by the observer at each gage. Several tests were made on each size of column, and the consistency of the concrete and the time of pouring were varied to determine the effects of these factors upon the lateral pressure.

The accompanying diagrams (Fig. 3) give the results of four tests with the 12-in. square column and of the two tests for the 20-in. square column. The readings of the different gages are noted by symbols that are designated on each diagram.

The tests of the 12-in. column form varied in time of pouring from 3 to 9 min.; and of the 20-in. column form, 6 to 14 min. The consistency of the concrete varied from quaking or medium to very wet. Difficulty was experienced in securing a uniform rate of pouring during any one test. It was noticed that the material as it discharged from the skip was not of a uniform consistency, owing to the loss of water in handling the concrete and the tendency of the wetter upper section of the concrete in the skip to discharge before the general mass.

An effort was made to determine the effect of impact by special tests in which the concrete was poured in layers 1 ft. in depth and an intermission of 15 sec. allowed between successive layers. The highest reading on each gage during the pouring of each layer of concrete and also the lowest reading during the succeeding interval

were recorded. The results gave in each case a definite reduction in pressure after the pouring ceased; but as only one test was made on each size of column, there is insufficient information for drawing conclusions.

Conclusions of Laboratory Tests

The tests were not sufficiently comprehensive to permit the statement of any definite laws regarding the lateral pressure of wet concrete. Conditions of testing were found to be so variable that it is difficult to make close comparisons between the results of different tests even on the same size of column form. However, it is believed that the following general conclusions are justifiable:

1. The lateral pressure increases with the head up to a certain point, after which the pressure remains nearly constant until the pouring ceases. It is probable that, during the early part of the pouring, the concrete is supported by pressure upon the base of the form, and later a considerable part of the concrete is supported by arch-like action on the sides of the form. In this respect the action of green concrete seems to be similar to that of grain, seeds, clean dry sand, etc., in a bin.

2. The lateral pressure in general corresponds to hydrostatic pressure for wet concrete.

3. The lateral pressure increases with the rate of pouring and the degree of wetness of the consistency.

4. The lateral pressure is about the same for column forms up to 20-in. square.

Tests Made on Large Bridge Post

A series of field tests were conducted on a reinforced-concrete arch viaduct that was under construction across the North Fork of the Vermilion River at Danville, Ill., during the summer of 1915. The object in making these tests was to get more data than had been obtained in the laboratory and also to get information by which a comparison might be made of lateral pressures under laboratory and field conditions. It is often argued that results obtained in the laboratory are of little value, because conditions do not approximate those existing in actual construction.

The viaduct is of the arch-rib type, with spandrel posts, floor-beams and slab floor. The tests were made on the spandrel posts of the longer spans. These posts have a cross-section of 23x30 in. and a maximum height of about 15 ft. They have both vertical and horizontal reinforcing bars.

The vertical reinforcement consists of 1-in. square bars, one of which is placed in each corner of the post. The horizontal bars are ½-in. squares spaced about 3 ft. on centers. Particular care was taken to so locate the pressure gages that the reinforcing bars would not interfere with the pressure of the concrete upon the gages.

The apparatus (Fig. 4) consisted of the same iron rings and pressure gages that served in the laboratory tests, a level rod with a flat piece of sheet-iron fastened to the end to provide bearing area (for measuring the height of concrete), a stop watch and a whistle. Two rings were placed in each of the four long posts on one span and just as near the bottom of the post as was practicable. Since the spandrel posts, floor-beams and floor slabs for one span were poured in one day, there was no opportunity to move the rings during the process of pouring and get readings on other posts in that span. By the method outlined it was possible to get eight gage readings during the pouring of one span.

The materials used in making the concrete consisted of a standard cement and a good grade of washed Wabash

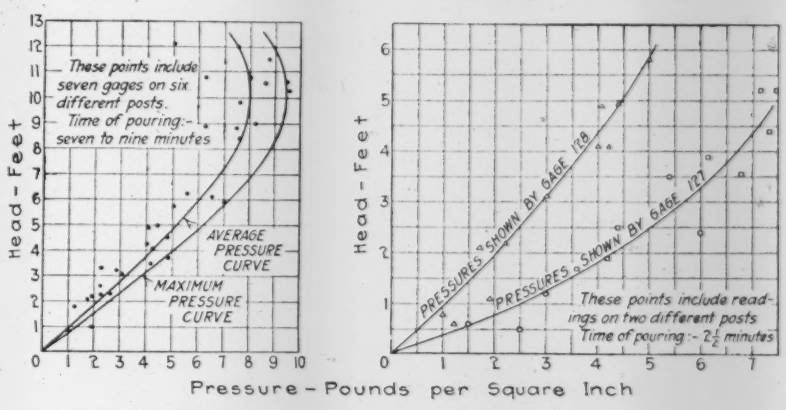
These points include seven gages on six different posts.
Time of pouring:- seven to nine minutes
AVERAGE PRESSURE CURVE
MAXIMUM PRESSURE CURVE
Head - Feet
PRESSURES SHOWN BY GAGE 128
PRESSURES SHOWN BY GAGE 127
These points include readings on two different posts
Time of pouring:- 2½ minutes
Pressure - Pounds per Square Inch

FIG. 5. PRESSURE-HEAD DIAGRAMS FOR 23x30-IN. POSTS ON BRIDGE

River sand and gravel. The proportions by volume of cement, sand and gravel were 1:2:4. The maximum size of gravel permissible was that which would pass a 1¼-in. screen. A batch mixer mixed the concrete, and a spouting system transported the mixed concrete to its place in the forms. The consistency of the mixture was wet. The rate of mixing was about one batch per minute. It required from 7 to 9 min. to fill one of the spandrel posts with concrete.

The gages were calibrated both before and after making each series of tests in the manner described previously. Four men were required for carrying on the tests—one to put in place each of the two gages in a post form and to record the pressure readings when the concrete was poured; one to time the pouring of the concrete with a stop watch and blow a whistle as a signal for the gage readings to be taken and the height of concrete to be measured; and one to measure the height of concrete when the signal was given.

The increase of pressure as indicated by the gages was not constant, as one might suppose. The gages indicated an increase of pressure by jumps, as though the aggregate would form an arch across the column form and by suddenly giving way cause the gages to show a sudden rise in pressure. It was also noticed that upon the discontinuance of pouring of concrete for a few seconds the pressure would begin to drop. There was some leakage of water from the forms, but apparently this had no effect on the pressure.

If, after the concrete had reached a height of 5 or 6 ft. above the gages, the pouring was discontinued for a few seconds, the gages would seldom show an increase in pressure when pouring was resumed. Apparently the concrete had had sufficient time to settle into a stable position, and the impact of the new concrete was not sufficient to jar it loose and thus increase the pressure at the gages.

A total of 16 readings was taken in the field tests. Of these 16, nine appeared to be very consistent, and they

were used in plotting the curves shown in the accompanying diagrams (Fig. 5). The other seven gage readings were of such an erratic nature that it was not thought advisable to use them. In some cases no pressure whatever was recorded, indicating that there had been some obstruction in front of the diaphragm, while in other cases no pressure was indicated at first, but after a while there would result a sudden rise in pressure amounting nearly to the same maximum recorded by the other adjacent gage.

While pouring the concrete, the end of the spout rested on the floor-slab forms and the concrete was permitted to drop from this point into the post forms. In falling, the concrete would strike one side of the post before dropping to the bottom. Apparently this had no effect on the gage readings for the long posts; but for the short posts, for which the pressures are shown at the right in Fig. 5, gage 127 was on the side opposite the spout, and the curve indicates that the concrete dropping near the gage caused an appreciable increase in the pressure. Gage 128 was placed on a side of the form adjacent to the side on which gage 127 was located.

The diagrams give the recorded pressure in pounds per square inch for heads up to about 12 ft.

Conclusions From Field Tests

It will be observed that the pressure gradually increases with the head until a maximum is reached, after which the pressure falls off. The height at which this maximum pressure occurs depends upon the consistency of the concrete and upon the rate of pouring.

The actual pressures recorded approximate very closely that of a liquid having the same weight as the concrete, or about 145 lb. per sq.ft. per ft. of head.

The results obtained from the field tests agree closely with those secured from the laboratory tests.

Concrete falling against the forms may result in high lateral pressures due to impact.

A value of 145 lb. per sq.ft. per ft. of height would be a rational value for lateral pressure to use in the design of forms.

The results of these tests are not conclusive, but it is believed that they are sufficiently consistent and accurate to furnish lateral-pressure values which may be used as a basis for the design of forms under average working conditions.

Details of Old Iron Viaduct in Service 37 Years

By Edgar K. Ruth*

In *Engineering News* of Apr. 6, 1916, the writer described briefly the plant used for the construction of the new reinforced-concrete arch viaduct that will carry Park Ave. over Kemper Lane into Eden Park in Cincinnati. In the design and operation of this plant the contractor made profitable use of one span of the old iron viaduct replaced by the new viaduct. It has been suggested that a brief history and description of this old structure would be interesting.

The original Park Ave. Viaduct, or "Kemper Lane Bridge," as it was often called, was built probably in the early sixties. Painstaking examination of the city records and annual reports of the city engineer as far back as 1854 reveals only that this old structure was about 267 ft. long, that it consisted of several short iron truss through spans, that its first cost was about $25,000, and that in 1876, being in a "ruinous condition," it was closed to traffic and torn down.

The new viaduct, completed in 1878, did not, however, contain a great deal of new iron, for with a commendable effort toward economy, instead of discarding as useless the material in the old viaduct, the bridge

*Assistant Engineer, City Engineering Department, Cincinnati, Ohio.

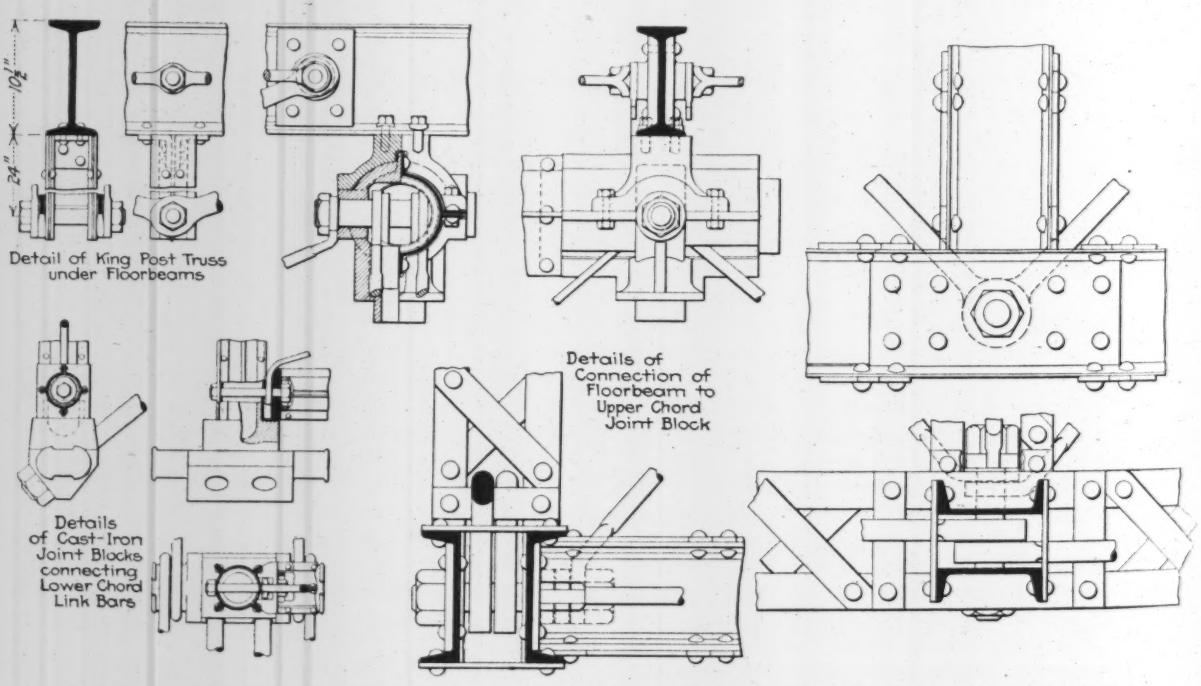
10½"
24"
Detail of King Post Truss under Floorbeams
Details of Cast-Iron Joint Blocks connecting Lower Chord Link Bars
Details of Connection of Floorbeam to Upper Chord Joint Block

FIG. 1. SOME DETAILS OF THE STRUCTURAL IRON WORK ON THE PARK AVE. VIADUCT AT CINCINNATI

FIG. 2. VIEW OF ONE END OF THE OLD PARK AVE. VIADUCT, CINCINNATI

engineer utilized a large part of it in building the new structure. The cost of the ironwork was about $10,000, and the entire improvement, including masonry and excavation, cost $22,500. The total length of the new viaduct was 353 ft., made up of six Pratt truss deck spans, one of 66 ft. over Kemper Lane, four of 57 ft., and one of 53 ft. at the Eden Park end.

Quoting from the annual report of the city engineer for 1878: "The new superstructure is far superior to the old one as regards strength, durability and appearance, but of course the details of construction are not as perfect as they would have been could less of the old materials have been used. As it is, nearly all of the iron of the old bridge was worked into the new one, while the woodwork is entirely new."

Some of the details of this "new" viaduct are of interest, in view of the fact that it was used continuously from 1878 to 1915, required practically no repairs, except to its wooden floor, and was painted only a few times in that period.

Each span consisted of two Pratt trusses 17½ ft. c. to c., with 8-ft. panels, supporting 10½-in. I-beam cross-girders 32 ft. long. These I-beams cantilevered beyond the trusses 7 ft. to carry the sidewalk on each side of the 18-ft. roadway. They were trussed by shallow king-post trusses with eye-bar tension members and 4-in. I-beam struts.

The design of the trusses was unique, in that the upper-chord members, vertical web members and horizontal struts between corresponding panel points in the lower chords of trusses were all built up from Phœnix-column sections, and the lower-chord tension members were wrought-iron link bars. Special cast-iron joint blocks were used at panel points to connect the various members.

The viaduct was torn down in July, 1915, to make way for the new concrete structure, and about 105 tons of material was sold as scrap. The bars and links showed little signs of corrosion, but the Phœnix sections were in many instances badly pitted and rusted, especially at the ends, where connected to the joint blocks.

Steel Shell for Water Tunnel

Part of the 8-ft. suction tunnel leading from the 12-ft. Wilson Ave. intake tunnel of the new Mayfair pumping station, at Chicago, has an exterior steel shell. The tunnels from the east gate shaft to the two screen shafts were excavated in clay in the usual manner. The clay being hard, an advance of about 6 ft. was mined and concreted per shift. The suction tunnel in the building is subjected to great pressure from the adjoining foundation walls of the pumproom and heavy pump foundations. For this reason and because better progress and a certain saving can be made if the mining and lining operations can each be carried on continuously (instead of alternating, as is customary), steel lining plates were employed in this part of the tunnel. These plates form a continuous steel shell of the outside diameter of the tunnel and the concrete lining can be deferred until the entire tunnel is excavated. The location of the tunnel made very heavy reinforcing necessary, and this too could be handled much more advantageously in a completed bore than in the usual crowded conditions resulting from alternate mining and lining. This steel shell was described in a paper on the Wilson Ave. tunnel, read before the Western Society of Engineers by Henry W. Clausen, Engineer of Water-Works Construction, Chicago.

Coöperation Between the Boston Health and Police Departments is to be increased. Heretofore the police have helped in the detection and prosecution of offenses against health laws and regulations. Hereafter the police will give notice of conditions which do not admit of prosecution by them, but which are subject to remedy by direct action of the health authorities.

Engineering Literature

CORRESPONDENCE

Engineering Thermodynamics

Sir—The reviewer of Moyer and Calderwood's "Engineering Thermodynamics," in *Engineering News* of Feb. 17, 1916, has apparently the idea that, if the subject is to be presented clearly, it is necessary to use only "words of one syllable." There is, however, a big jump from the abstruse treatises on this subject by Zeuner, Rankine and Peabody to discussions limited to words of one syllable. It is the jump from involved and partly explained calculus to the language of the primary grades. There is no reason to assume that the authors made such claims as regards the length of words. They had in mind, however, the preparation of a book in which the text would be "largely self-explanatory."

It is admitted by the reviewer that many difficulties with other treatises have been overcome in this one. His explanation is that the difficulties have been avoided "by the omission of some of the more difficult subjects normally considered desirable."

The argument that thermodynamics should be a "hard subject" and not a college "snap" has no more reasonableness than that of the old-fashioned pedagogue who contends that algebra is necessary for the proper mental development of girls in city high schools, in spite of the fact that these girls are notably deficient in the fundamentals of arithmetic. Doubtless, thermodynamics as given in the college of engineering with which the reviewer is connected is arranged to give the maximum amount of pleasure to the instructor in presentation and the maximum amount of difficulty to the student. I am confident that, after 10 years of experience in engineering, practically all of these students will join those who condemn such methods of teaching. In connection with their practical work they will probably never refer to their textbook, but will use books that are written in plain English, with little calculus; the kind of thermodynamics found, for example, in Kent's "Mechanical Engineers' Pocket Book."

The authors believe it is a crime to teach the subjects of thermodynamics and descriptive geometry according to the old-fashioned methods. Teachers having the viewpoint that these subjects should be made difficult for the sole purpose of separating the "sheep from the goats" cannot justify themselves pedagogically.

The reviewer says there are statements "likely to be misleading for the student." His first citation is the use of the words "practically perfect vacuum," but no page reference is given. These words are used on page 10 in regard to gas in a cylinder connected to an air pump. It seems unnecessary to demonstrate that a "perfect vacuum" was impossible with any apparatus.

Exception is also taken to the statement of the reviewer that it is necessary to "distinguish between adiabatic changes which are isentropic and those which are not." This is a matter which cannot be settled on the basis of authority. The authors have certain ideas as to the importance of this matter, and the reviewer has different notions. It is the opinion of many engineers that the "average student" will have no use for this distinction.

Other trivial statements in the review are of similarly doubtful accuracy and may be judged as to their merits by the preceding discussion.

J. A. Moyer, J. P. Calderwood.

Massachusetts Department of University Extension, State House, Boston, Mar. 25, 1916.

REVIEWS AND NOTES

Harbor Section Added to Civil Engineers' Pocketbook

AMERICAN CIVIL ENGINEERS' POCKET BOOK—Mansfield Merriman, Editor-in-Chief. Third Edition, enlarged. New York: John Wiley & Sons, Inc. Leather; 4x7 in.; pp. 1,571; illustrated. $5 net.

Although the third edition of this standard pocketbook contains a number of minor changes, its important feature is the addition of an entirely new section on "Harbor and River Works," by Rear Admiral Frederic R. Harris, of the Corps of Civil Engineers, United States Navy, now chief of the Bureau of Yards and Docks. Thus is supplied the one field of civil-engineering practice conspicuously absent in the earlier editions.

Of the 95 pages in the new section, only 12 are devoted to rivers, the other 83 taking up the details of harbor engineering, or at least those types of marine construction which result from the necessity for harbors. In this respect the author has a certain justification not only because river works appear in some detail in other sections of the pocketbook, but because while the literature of river control is fairly extensive, American books on harbor engineering are practically nonexistent.

The section starts with a brief treatment of the hydrology of harbors, followed by details of protective structures such as breakwaters and groins. The river chapter, which follows, has the usual hydrological facts with a short, rather incomplete exposition of regulation and control. The next three chapters are on quays, piers and docks and are the best of the section. A final chapter is mostly devoted to port machinery.

The new section is quite up to the high standard of the rest of the book. In view of the current agitation it is somewhat strange that more attention was not paid to river control, but after all, the knowledge in this field does not lend itself readily to pocketbook condensation. So, too, it seems that more space might have been paid to quay and dock walls and less to dry docks. Dry-dock construction is necessarily limited, but quay walls are being built everywhere there is a navigable stretch of water. In no other branch of structural engineering has there been such a pronounced development, and the detailing of this development would make valuable reference matter.

Electric-Railway Fares

STUDIES IN THE COST OF URBAN TRANSPORTATION SERVICE—By F. W. Doolittle, Director, Bureau of Fare Research, American Electric-Railway Association. New York (8 West 40th St.): E. B. Burritt, Secretary of Association. Cloth; 6x9 in.; pp. xii + 467; 56 illustrations. $3.50.

A couple of years ago the American Electric-Railway Association established its Bureau of Fare Research to continue more rapidly and uninterruptedly the studies that had been carried on in the past by certain of its committees. The author of the book in hand became the director of this bureau and its chief worker; from time to time there appeared in *Aera*, the official association paper, and in *Electric Railway Journal* various articles by him on the collection of traffic and cost data for street railways, comparative operating results of American roads, etc. Those occasional papers now appear to have been parts of a comprehensive plan, for they have been gathered up in this volume with such connecting and extending matter as is required by the title.

The book, in effect, is essentially an argument for the cost-of-service theory in making street-railway rates and an exposition of the ways in which the cost of carrying passengers over various parts of a system may be fairly approximated. If the explained measures be followed, there would result a general adoption of something like the European small-fare zones—or perhaps better, like the scheme used in Milwaukee, of a central 5c. zone and outlying 2c. zones, all fixed by the cost of carriage on the several lines. The returns on capital in the electric-railway industry appear to be so meager (averaging 4.9% on bonds and 2.6% on stock, according to the 1912 United States census) that the managers would evidently welcome any practical change that would give them cost plus a profit—leaving to academic halls all discussions of roseate dreams of fares based on "value of service."

So long as this book is an official manual of the organized industry and a natural part of its normal propaganda, by many it will be regarded with suspicion. But although necessarily more or less partisan, nevertheless it should be of great use, inside the industry and out, for it is well conceived, is broad in scope and employs data from regulating commissions, government bureaus, independent engineers and economists, as well as from the officials of supporting railways. A tremendous amount of matter has been squeezed into small space by use of small type—so small as to discourage reading except by those vitally interested.

The book opens up, under the chapter heading "Creating the Street Railway," with a statement of how overhead costs—intangible values—are brought about. Where the nickel goes to is shown by a review of census and company reports on operating and fixed charges, etc. The upward trend of labor and of all railway operating costs is compared with price movements in general. Matters of valuation and depreciation are briefly dismissed with a statement of the theories of utility value—market, sacrifice, agency—and the need of securing cost of replacements from earnings.

A considerable section is occupied by discussions of the peculiarities of street railways as operating utilities, the difficulties of intelligently comparing unit figures, the collection and use of traffic data prior to finding real cost of service and fair operating standards. Methods are shown for computing the effect of proposed line extensions on cost and revenues, the profitable length of haul on various parts of a system and the related matter of widths of possible small-fare zones.

After reviewing the detailed costs of competing forms of city-transit service the author comes to the comforting conclusion that the electric railway is in the most advantageous position and that the jitney bus, once saddled with all the tax burdens it creates, cannot continue in importance. One long chapter shows wherein the riding habit of a city has been more influenced by various local conditions than by any changes of street-car fare—up or down. The final chapters of the volume give the varied details of operation in Cleveland and Milwaukee—the 3c.-fare and the zone-system cities which stand unique among American municipalities in their departures from common practice.

Iron and Steel Analysis

REVIEWED BY ROBERT JOB*

THE SAMPLING AND CHEMICAL ANALYSIS OF IRON AND STEEL—By O. Bauer and E. Deiss, of the Royal Testing Bureau at Gross-Lichterfelde, Germany. Authorized translation from the German by William T. Hall and Robert S. Williams, Massachusetts Institute of Technology. [International Chemical Series.] New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 373; 173 illustrations. $3. net.

The object of the translators in bringing this useful work to the attention of American chemists has been to emphasize the extent of segregation in iron and steel and place those in charge of sampling upon their guard against errors which may easily occur unless precautions are taken. Photographs show the variations in composition and in structure which may be expected in iron or steel, and methods of analysis are given in detail, showing both German and American practice. The translation is placed in the International Chemical Series by Dr. H. P. Talbot, of the Institute of Technology, as Consulting Editor.

Unfortunately for the chemist, the sampler too often has little or no idea as to the wide differences in composition and in structure that are frequently found in a piece of metal within a very limited area, and in consequence those called upon to make analyses of samples thus taken obtain results that may be misleading and cause loss. This lack of knowledge upon the subject unfortunately does not stop with the sampler, but in too many instances extends to the works' manager and leads at times to misstatements and bad practices which result at the very least in great confusion.

The authors of the work give a good description of apparatus used in metallographic work, with clear directions as to procedure. In most cases the best standard practice is given, though in the directions for sulphur prints we miss the usual procedure of taking prints directly upon photographic paper instead of upon silk.

The commoner microscopic constituents of iron and steel are shown clearly by means of typical photomicrographs, so that even those who have not made a special study of the microscopic structure of iron and steel find much to interest and to instruct. As a matter of fact, comparatively few persons think of steel as a metal of complex structure, though such is the case, and one often finds as a result of study of the microscopic constituents that a clue is given which enables one to state

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definitely the cause of what otherwise would be termed a mysterious failure of steel. A description, with characteristic etchings, is also given of the "macroscopic" appearance of iron and steel—that is to say, the etched appearance of larger sections of the commercial forms, such as ingots, bar iron and rails.

The larger portion of the book is taken up with the details of methods of analysis of iron, steel and of various materials used in the manufacture of steel, and as a whole this portion of the work will be found of decided interest to the analyst, not merely through the placing of various methods in convenient form for reference, but also by enabling one to compare easily German and American practice. In some cases the former is cumbersome as compared with our quicker and equally accurate methods, as for instance, the Corleis' chrome sulphuric acid method for determination of carbon in steel, as compared with the direct combustion in the electric furnace.

Under the methods for manganese the persulphate method which is in use in most American mills is not given, but works' chemists who have occasion to use routine methods can find the details readily in the yearbook of the American Society for Testing Materials or in other books of reference.

The book will be of value in any laboratory or mill, especially owing to the timely reference to the importance of correct sampling.

On Military Engineering

MILITARY PREPAREDNESS AND THE ENGINEER—By Ernest F. Robinson, Assoc. M. Am. Soc. C. E., Captain, Corps of Engineers, N. G. N. Y. New York: The Clark Book Co. Cloth; 4x7 in.; pp. 224; 75 illustrations. $1.50.

The interest that civilian engineers, all over the country and of all grades of responsibility, are taking in military science has been marvelously demonstrated by the multiplication of organizations for lecture and reading courses, practice drills, etc.; but fully as many interested engineers are not in or close to large centers and hence are somewhat at a loss to know how to approach self-preparation for military-engineering service. This book is designed to help such men; it will do that, and it will also serve those who sit in lecture halls or thumb military texts. For the one class it is a good primary text, opening up the field and orienting the would-be officer's ideas; for the second group it gives better notes on the lectures and elementary texts than even a careful student would make.

It is not, and makes no pretense to be, the be-all and end-all of patriotic preparation. At the outset the author divides engineers in warfare into those in the advanced zone and those in the communication zone—the latter men retaining practically all the characteristics of engineers in civil life. The activities of men in the advanced zone alone are discussed. Various ways open for securing military training are explained—naturally with a strong plea to support the National Guard. Then the organization of the United States Army is sketched, and the important administrative duties of an officer are explained. Why volunteer troops have too often slept supperless is one of the interesting little points here—and is one reason for including this chapter.

Duties, organization and equipment of engineer troops in the field are quickly disposed of. A chapter is interjected on teaching men to shoot and on the effect of various fires. The need, layout and practical construction of field fortifications (trenches, parapets, gun emplacements, obstacles, etc.) are presented, and then sapping and mining offense. A lecture on high explosives, by Prof. M. C. Whitaker, of Columbia University, is placed before notes on demolitions. The chapter on bridges opens with military loads, pictures various knots and hitches and shows spar and pile structures; but it spends the most of its space, naturally, on ponton crossings and American ponton equipage. The final technical discussion of the little volume is a review of topographical mapping. The book draws to a close with a brief exposition of the need for engineers in war and for a last time dwells on the truism that adequate personal military training is a first requisite. Appendix I reprints the Chief of Engineers' reading list for interested civilians (given in *Engineering News*, Mar. 16, 1916). Appendix II shows a list of engineering property carried in the field by an engineer company.

Theory of the Universe

THE UNIVERSE AND THE ATOM: The Ether Constitution, Creation and Structure of Atoms, Gravitation and Electricity, Kinetically Explained—By Marion Erwin, C. E. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. 314; 58 illustrations. $2.

This is a most unusual book and comes from a most unusual source. The author presents a theory of the constitution of matter and energy and of the entire physical universe, basing his theory on the principles of mechanics. The conclusion which he reaches as the results of his research is that the celestial bodies—suns, stars and worlds, floating through space—are not limited in number and extent, according to the belief hitherto generally held, but are actually infinite in extent.

The vastness of this conception leaves one breathless, but the author supports it by extended discussion based on the researches of the most eminent scientists. It will be manifest that to prove a proposition of such stupendous magnitude within the comparatively narrow limits of the volume before us would be extremely difficult. The author very frankly says that a book could be written on almost every subject treated in the several chapters. He has attempted to present only the principles that underlie his fundamental proposition.

The reviewer makes no pretense of passing an opinion here on the soundness of the theory which Mr. Erwin has presented. The subjects treated in his book have long been fascinating topics for speculation by scientists everywhere, and his theories and conclusions will doubtless receive careful study from those competent to analyze them.

It is of no small interest to the readers of *Engineering News* to observe that, while the author of this book is an eminent attorney, he graduated from college with the degree of Civil Engineer; and he intimates in his preface that it was his college studies in science and mathematics that aroused interest in original research and led him into the train of studies of which this book is a result. As evidence that the author combines ability in his own profession with his interest in physical science, it is of interest to record that some 15 years ago he was United States District Attorney at Savannah, Ga., and upon him fell the responsibility for conducting the prosecution of Gaynor and Greene, the contractors for river and harbor work in the Savannah district who conspired with ex-Captain Oberlin M. Carter in the late 90's to defraud

the United States. It was largely due to Mr. Erwin's ability and energy in the prosecution of this case that after years of battle in the courts, not only were the contractors convicted and sentenced, but a large part of the funds which Carter had dishonestly secured was recovered by the Government.

New Jersey Riparian Rights

WATERWAYS OF NEW JERSEY: History of Riparian Ownership and Control Over the Navigable Waters of New Jersey—By Charles S. Boyer, Formerly Member of New Jersey Harbor Commission. Camden, N. J.: Sinnickson Chew & Sons Co. Cloth: 6x9 in.; pp. 295; illustrated. $2 postage prepaid.

This book contains the results of extensive research with reference to the ownership and control of navigable waters in New Jersey. To determine the title to riparian lands in the state it is often necessary to go back to the records of original proprietorship, and the first part of the book is taken up with an interesting review of colonial history and the successive and conflicting grants of lands within the state. The author reviews also the history of the state boundary lines and controversies which have taken place in connection with them. In the chapters headed "Rights and Titles to Riparian Lands," "Alluvion," or land formed by the deposit of material in a body of water, and "Federal Authority Over Navigable Waters" the author presents a terse review of the law on these subjects in a way that is intelligible to anyone and may be useful to many engineers. The principal New Jersey waterways described in the book are the old Delaware & Raritan and Morris canals, the Inland Waterway, or channels through the salt marshes parallel with the coast, and the proposed ship canal across New Jersey, for which the Federal Government has made surveys. While the book relates primarily to New Jersey, it contains material of interest to any engineer who may have to look up the legal status of a project involving riparian rights.

Kidder's Pocket-Book Revised

THE ARCHITECTS' AND BUILDERS' POCKET-BOOK: A Handbook for Architects, Structural Engineers, Builders and Draftsmen—By the late Frank E. Kidder, author of "Building Construction and Superintendence." Compiled by a staff of specialists, Thomas Nolan, Editor-in-Chief, Professor of Architectural Construction, University of Pennsylvania. Sixteenth edition, rewritten. New York: John Wiley & Sons. Flexible leather; 4x7 in.; pp. xxiii + 1,816; illustrated. $5 net.

The "Architects' and Builders' Pocket-Book" was first published under the authorship of the late Frank E. Kidder in 1884 and went through 14 editions under the author's direction up to 1904. After Mr. Kidder's death a fifteenth edition was published, including some new matter mainly on fireproofing of buildings and reinforced concrete, and now appears the sixteenth edition, entirely revised and rewritten. This latest edition, produced under the direction of Thomas Nolan, Professor of Architectural Construction, University of Pennsylvania, as editor-in-chief, follows fairly closely the general plan of the original handbook, but is an entirely new publication, both mechanically and editorially. The plan originated in the "American Civil Engineers' Pocket-Book" of having different specialists write on their particular subject has been followed.

These specialists and the general titles of their subdivisions are as follows: Thomas Nolan, "Terms Used in Architectural Engineering," "Masonry Walls, Footings for Light Buildings, Cement and Concrete," "Strength of Brick, Stone, Mass Concrete and Masonry"; Daniel E. Moran, "Foundations"; G. T. Snelling, "Retaining Walls, Breast Walls and Vault Walls," "Stability of Piers and Buttresses," "Stability of Masonry Arches"; Malverd A. Howe, "Forces and Moments," "Types of Roof Trusses," "Stresses in Roof Trusses," "Design and Construction of Roof Trusses"; Charles F. Warren, "The Action and Bending Moments for Beams," "Properties of Structural Shapes, etc.," "Strength of Columns, Posts and Struts, etc.," "Stiffness and Deflection of Beams," "Strength of Beams, etc.," "Strength and Stiffness of Continuous Girders, etc.," "Riveted Steel Plates" and "Box Girders"; H. C. Berry, "Resistance to Tension," "Properties of Iron and Steel," "Resistance to Shear," "Riveted Joints, Pins and Bolts," "Bearing Plates and Bases for Columns, Beams and Girders," "Brackets on Cast-Iron Columns"; F. H. Kindel, "Strength of Beams," "Strength of Built-Up, Flitched and Truss Wooden Girders"; A. P. Stradling, "Wooden Mill and Warehouse Construction"; Rudolph P. Miller, "Fireproofing of Buildings and Reinforced-Concrete Construction"; E. G. Perrot, "Reinforced-Concrete Factory and Mill Construction"; N. A. Richards, "Wind Bracing for Tall Buildings"; R. C. Carpenter, "Heating and Ventilation," "Heat, Fuel, Water, Steam and Air"; J. J. Cosgrove, "Hydraulics, Plumbing and Drainage," "Gas and Gas Piping"; W. H. Timbie, "Lighting and Illumination of Buildings," "Electric Works of Buildings"; Wallace C. Sabine, "Architectural Acoustics."

This enumeration of authors and subjects is quite sufficient to indicate the breadth of the treatment. So far as can be judged from a casual inspection, the method of discussion is very good. The book has undoubtedly been greatly improved in its revision and now constitutes a valuable reference not only for architects, but also for engineers, particularly those engineers who are concerned with any kind of building work—which indeed embraces practically all of the profession.

Concepts of Electric Theory

THE PRINCIPLES OF DYNAMO ELECTRIC MACHINERY—By Benjamin F. Bailey, Professor of Electrical Engineering, University of Michigan. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 314; 222 illustrations. $3 net.

Professor Bailey has apparently found the fairly common trouble of students seeming to grasp certain details of electrical theory while not comprehending the fundamental physical concepts involved or the inter-relations of actual phenomena taking place. It is to be presumed that he has had considerable success in evolving teaching methods that prevent such a lamentable condition in his school and that this text shows them.

Throughout the book, evident attempt has been made, first, to describe the fundamental phenomena involved in the operation of the various common pieces of commercial electric machinery and then to outline the more important physical reactions of the apparatus. Naturally, the mathematical development of theory has been given a secondary place, though the shorthand notation furnished by mathematical formulas has been freely employed. The students who are to use this book, or to follow courses based on such procedure, must have a thorough grounding in elementary physics, including

mechanics, for the text does not go back to quite the most rudimentary basis. The book is not to be thought of as a treatise for the "practical" man—the mechanic; in spite of its dealing with definite realities of commercial equipment it does not (nor should it) get down to touch the actual bolts and nuts, collector rings and commutator bars, rubber insulation and iron cores in a way to appeal to anyone but the young technical student or his teacher.

There is, first, the general matter on magnetism, current, resistance, etc. Then some preliminary notes on motors are followed by an outline of electrical distribution systems, old and new. Direct-current generators and motors are taken up again and more in detail, with interjected chapters on accessories and measuring instruments. This uses up a little less than half the book, the rest of which is devoted to alternating currents. Much the same procedure is followed there too, general definitions being followed by properties of circuits, instruments, distribution systems, transformers, synchronous and induction motors and generators, rotary converters and commutating motors.

American Railway Statistics

RAILWAY STATISTICS OF THE UNITED STATES OF AMERICA for the Year Ending June 30, 1915, Compared with The Official Reports for 1914 and Recent Statistics of Foreign Railways—Prepared by Slason Thompson. Chicago: Bureau of Railway News and Statistics. Paper; 6x9 in.; pp. 147.

This is the twelfth annual issue of this book of railway statistics. The compiler of these statistics, Mr. Thompson, is the avowed advocate and defender of the railways, but the statistics he presents are none the less interesting and convenient, especially as he furnishes statistics on a great variety of railway matters which one would have to hunt through many official documents to gather for himself. Of special interest just now, in view of the demands upon the railway companies made by the railway trainmen, are the statistics regarding employees' compensation. It appears from these tables that enginemen, whose average pay was $3.68 in 1892, received in 1914 $5.24. Railway brakemen and flagmen, whose average daily pay was $1.89 in 1892, received $3.09 in 1914. The pay of railway yardmen, on the other hand, has remained almost stationary. Switchmen, flagmen and watchmen received $1.78 per day in 1892 and $1.71 per day in 1914. Railway employees of all classes in the year ended June 30, 1915, numbered 1,542,000, and their average annual compensation was $825. It is interesting to compare these annual earnings of railway employees in the United States with those of railway employees in other countries. Mr. Thompson gives the following figures for the average earnings of railway employees in the principal countries of Europe: United Kingdom, $279; German Empire, $409; Austria, $330; Russia, $211; France $260; Switzerland, $368; Japan, $113.

It is fair to say that these figures, while the latest obtainable, are in some cases several years old, and Mr. Thompson states that war conditions and the increased cost of provisions have compelled an advance in railway wages in the principal countries of Europe.

An idea of the scope of the book may be gained from headings of some of the principal chapters, as follows: Railway Mileage in 1915; Equipment; Employees and Compensation; Capitalization; Cost of Construction; Ownership of American Railways; Public Service of the Railways; Locomotive Fuel; Accidents; Cost of Railway Regulation. Under the head of "Recommendations" Mr. Thompson says:

> If regulation of American railways is to continue along the present lines of subordinating the transportation necessities of a continent to the petty interests of individual shippers, the sectional jealousies of states and the rivalry of communities, nothing in the way of temporary relief can save it from the inevitable collapse into the incompetent hands of the state.

Design of Masonry Dams

MASONRY DAM DESIGN; Including High Masonry Dams—By Charles E. Morrison, C. E., Ph. D., Formerly of the Civil Engineering Department of Columbia University, and Orrin L. Brodie, M. Am. Soc. C. E., late Assistant Designing Engineer, New York Board of Water-Supply. Second Edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. ix + 276; 47 illustrations. $2.50 net.

The first edition of this book (reviewed in *Engineering News*, June 16, 1910), was entitled "High Masonry Dams." The second edition includes practically all of the information in the first and has been amplified to the extent of writing general expressions wherever possible, so that the design of low and medium-size, as well as high, masonry dams may be prosecuted according to the theory and methods developed. Besides, there have been added chapters on overfall dams and arch dams and a long illustrated list of the large masonry dams already built. The first edition has already been accepted as a standard of succinctness and completeness. The second adds very valuable material.

Kutter, D'Arcy and Bazin

REVIEWED BY ROBERT E. HORTON*

HYDRAULIC TABLES FOR THE FLOW OF WATER, in Circular Pipes Under Pressure, Timber Flumes, Open Channels and Egg-Shaped Conduits—By Joseph H. Harper, Civil and Mining Engineer, formerly of Harper, Macdonald & Co., Butte, Mont. New York: D. Van Nostrand Co. Flexible leather; 4x7 in.; pp. 192; 17 illustrations, 22 charts. $2 net.

This is an engineers' pocket-book of hydraulic tables based mainly on the Kutter formula. Tables of the flow in pipes are given for all the usual diameters for a series of eight slopes and for values of n in Kutter's formula of 0.010, 0.012, 0.015 and 0.020. Similar tables are given, based on the D'Arcy formula, for cast-iron pipe, both new and old. The tables are intended to constitute, as the author states, a "grill of solved problems" especially useful for "rough and ready calculations." A similar grill of solutions for special cases is provided for open rectangular channels covering widths from 4 in. to 40 ft. and depths from 2 in. to 8 ft., with six different slopes in each case. There is a table for each of the following values of n in the Kutter formula: 0.011, 0.013 and 0.015. Other tables cover the flow in open trapezoidal channels with side slopes of one on one. For the latter, separate tables are given, based on each of four forms of the Bazin formula and also on Kutter's formula with $n = 0.017$, 0.020, 0.025 and 0.030.

All the tables give velocities in lineal feet per second and discharges in cubic feet per second. The omission of quantities in gallons per 24 hr. hampers the use of the pipe tables for ordinary water-works calculations.

The tables are neat, concise and convenient in arrangement. They cover, however, rather a limited number of values within a wide range. They should prove very useful in preliminary studies for the comparison of the

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relative carrying capacity of conduits of different materials and slopes. They are accompanied by a discussion of the methods and accuracy of cross-interpolation for different cases. To facilitate accurate interpolation for intermediate slopes, the column heads contain slopes in terms of feet per mile and also the square root of the absolute slope. It seems unfortunate that the slopes in feet per thousand are not also stated.

The book contains many other useful hydraulic tables on orifices, weirs, etc., as well as an interesting discussion of the development of the formulas on which the tables are based.

Carbonization of Coal

REVIEWED BY ALFRED E. FORSTALL*

COAL AND COKE—By Frederick H. Wagner, M. Am. Soc. M. E., Gas Byproduct Lecturer in Johns Hopkins University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xii + 431; 137 illustrations. $4 net.

This book gives a compilation of articles and reports of investigations published during recent years upon various subjects connected with the carbonization of coal.

Under the heading Coal are treated the origin and varieties, the theory of spontaneous heating and combustion, the analysis and the storage of that material, together with the characteristics of coking and gas coals.

Under Coke are included carbonization for the production of gas in horizontal, inclined and vertical retorts and chamber ovens and for that of coke in beehive and byproduct ovens; the general principles of the gaseous combustion of solid fuel; the relative merits for coal-carbonizing plants of an individual producer for heating each bench of retorts or of a central plant of Kerpely producers each unit of which serves a number of carbonizing units; the heat balance of carbonization in retorts; low-temperature carbonization; the utilization for producing steam of the heat still remaining in the flue gases when they leave the recuperators or regenerators; and the quenching, screening and loading of coke at byproduct oven plants.

The descriptive matter is plentifully illustrated by cuts and plates. The author seldom gives his own opinion, and some discrepancies and inaccuracies were noticed which show lack of careful reading of the matter used. One instance of this, which is apt to mislead the reader unfamiliar with the subject, credits the Koppers ovens in Vienna with a gas-making capacity nearly ten times too large. The book, however, by means of its full résumé of recent literature, gives a good general treatment of the subjects covered.

Wood for Building

STRUCTURAL TIMBER BULLETINS. Timber for Structural Purposes—By E. A. Sterling. Engineering Bulletin No. 1. Chicago: National Lumber Manufacturers Association, Trade Extension Department.

In the first of a series of monographs on structural timber E. A. Sterling brings together a group of interesting facts bearing on permanence, cheapness and other advantages of wood for building. Fire-retardant paints and dips are mentioned, but they are to be treated fully in a separate bulletin soon to issue. On the question of cost the author shows that lumber is cheaper than it was 40 years ago.

*Forstall & Robison, Consulting Engineers, 84 William St., New York City.

Scale-Tables for Quantities on Railway Construction

LEVEL SECTION TRANSPARENT SCALES FOR PLATE "A" PROFILES, for Graduation, Arch Masonry and Iron Culverts—By F. W. Steber. Dallas, Tex. (2101 McKinney Ave.): The Author. Leather; 3x9 in. $2.50.

F. W. Steber has produced an entirely new device for quickly estimating railway-construction quantities. It consists of a book of transparent strips bearing scalar tables to the vertical scale of plate A profile paper, which when laid on the profile enable the user to read off the earthwork quantity per station or the amount of culvert masonry or the weight of culvert pipe, corresponding to the center height. The center heights need not be scaled, but give the quantity readings by their intersection with the column of quantity figures.

The tables of earthwork per 100-ft. station are given separately for three slopes—namely, $\frac{1}{2}$:1; 1:1 and $1\frac{1}{2}$:1. Auxiliary tables enable corrections for roadbed 2 ft. wider or for breaks in the side slopes to be read off in a single additional reading.

Each sheet is printed on transparent celluloid. The size of the leaves, $2\frac{3}{4}$x$8\frac{3}{4}$ in., and their arrangement in a book by pinning them together at one end enable any one sheet to be turned to place in a moment and applied directly to the profile of the line.

The author remarks that, since the determination of quantities from center height is apt to give results slightly lower than either mean end area or prismoidal calculations, there is a slight compensating advantage in the shrinkage of the celluloid, as this increases somewhat the quantities read from the tables.

The scales were made by photographic reduction on large layouts and are therefore considered to be accurate.

British Health Work

ENGLISH PUBLIC HEALTH ADMINISTRATION—By B. G. Bannington, Inspector of Nuisances, County Borough of West Ham. London: P. S. King & Son, Ltd. [Studies in Economics and Political Science.] Cloth; 6x9 in.; pp. 338. 7½s.

Such a comprehensive survey as this is sure to be welcomed and appreciated by American students of comparative government and of local and state health administration, although of course the book is of far more direct practical use in England than in the United States. A considerable amount of space is given to various sanitary and town-planning matters and to the control over health and sanitation exercised by the Local Government Board.

German Wireless Telegraphy

WIRELESS TELEGRAPHY—By Dr. J. Zenneck, Professor of Physics at the Technical High School of Munich. Translated from the German by A. E. Seelig. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xx + 443; 469 illustrations. $4 net.

Heretofore a knowledge of the details of German wireless-telegraph systems and apparatus has been easily secured only by those who were able to read some of the German texts—like Zenneck's own, which appear to have been highly regarded. The gap is now bridged by a translation of his well known "Lehrbuch." The translator, in making the change of tongue, has preserved the author's idioms by literal rendering wherever there was any chance that ordinary English phrases would not accurately convey the original meaning; as the preface states, he has preferred "to let Zenneck be Zenneck." It remains to be seen whether the readers will grasp Angli-

cized Zenneck better than they would translated Zenneck. The book of course is not merely a discussion of certain radio-telegraphic systems and apparatus, but a genuine treatise on the science and art of radio-telegraphy. The reader is assumed to have considerable technical training—a working knowledge of calculus and electrophysics.

The text first opens up with the topic of oscillations in circuits having capacity and inductance, and expands the treatment to cover the larger external electromagnetic and static fields. The next group of chapters deals with the properties of high-frequency circuits. Closer attention to equipment naturally comes in the sections on antennæ and aërials, transmitters, receivers and detectors, though the descriptions of apparatus are interrupted to discuss the propagation of waves over the earth and the directing of impulses. There is a brief chapter on wireless telephony. A particularly full bibliography is appended.

Mead's Water Power Revised

WATER POWER ENGINEERING: The Theory, Investigation and Development of Water Powers—By Daniel W. Mead, M. Am. Soc. C. E., Professor of Hydraulic and Sanitary Engineering, University of Wisconsin. Second edition. New York: McGraw-Hill Book Co. Cloth, 6x9 in.; pp. xvii + 843; 430 illustrations. $5 net.

The first edition of this book was highly regarded by most of those who used it as a guide into the mysteries of hydraulic power-plant design. The author frankly admits that the work had some important shortcomings. He therefore set himself to improving the book when the second edition became possible. As a consequence, the new volume is materially different from the first. The book is still unprepossessing in its make-up; the wallpaper end sheets, the crowded text, the Roman-type formulas, the many styleless line cuts and indistinct halftones, all conspire to give the volume a handicap that it does not deserve. Ten years ago the artistic engineering text had not been developed and these features would have aroused no comment; their persistence today in an important book like this calls attention to the progress that has been made.

The new edition contains no general discussions of hydraulics as a separate science, it being assumed that the reader is versed in its elements and applications. Hydrology, too, has been largely omitted (to appear in a later volume we are told). The study of turbine design (by means of efficiency-contour diagrams, etc.) has been strengthened until it is more easily grasped and more nearly meets the needs of engineers selecting waterwheels. The chapter bibliographies have been brought up to date more nearly—though there still are some instances of haphazard accumulation.

The author's historical notes on water power and waterwheels, particularly the latter, will appeal to anyone who has had to search for such material. The development of all the wheels is more specifically portrayed than in the books on wheels and turbines alone.

The text starts out with some historical notes, and shortly switches over to efficiency of machines and plants. There are notes on plant-load characteristics, stream flow and its changes, flow measurements, use of hydrographs. Then the author reverts to history—that of the better-known types of apparatus. A long section takes up the graphical analysis of turbine design, and after that goes into penstock and flume design. All the present-day apparatus makers appear to have been permitted to file a brief giving their progress—not a bad idea either. Descriptions of typical or notable plants are followed by an outline of dam construction. Finally, there are sections on costs of plants and output, financial and commercial aspects of hydro-electric plants, procedure in [illegible] of projects, and tables of important Holyoke Flume Tests on various runners, to show progress through the years.

Steinmetz "Elements" Revised

THEORETICAL ELEMENTS OF ELECTRICAL ENGINEERING—By Charles Proteus Steinmetz. Fourth edition, thoroughly revised and entirely reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 368; 194 illustrations. $3 net.

One of Steinmetz's best-known works on electrical engineering is his "Theoretical Elements of Electrical Engineering," which was originally written in 1901, and in 1915 ran through its fourth edition. The great expansion of the art and science in this period had brought so many actual and proposed additions to the text that it was found impossible to continue the issue of this work and its companion, "Alternating Current Phenomena." A radical rearrangement, therefore, has been started of both volumes. It is planned to withhold part of the material finally available for these two volumes and to incorporate this in a third member of the series.

The present volume, as would accordingly be expected, treats only the most fundamental matters of electrical engineering—such as magnetism, current, electromotive-force generation, properties of circuits, actions in synchronous-, induction- and commutating-type machines, vector diagrams, etc. The detailed treatment is that made familiar for several years by the author and needs no discussion here. There is one notable change, however—the substitution of the standardized "crank diagram" of vector representation for the author's preferred polar diagram, which gives an apparently anti-clockwise vector rotation. Notwithstanding the greater applicability of the polar diagram, the crank diagram is in greater favor for elementary books, and the author has recognized the confusion induced by non-uniformity among the leading texts.

Progress of Good Roads

GOOD ROADS YEAR BOOK, 1916—Fifth Annual Edition. Washington, D. C.: American Highway Association. Cloth; 6x9 in.; pp. 440. $1 per copy, $4 for five copies.

The first 180 pages of this useful annual are devoted to road legislation, etc., in the United States and Canada. Taking New York as a sample, there is given first a review of legislation relating to state-aid, local roads and bonds, convict labor, civil-service law applicable to road officials, automobile registration, list of highway officials, progress reports, road funds and publications issued. The information given for each state has been approved by the state highway engineer or highway commissioner or some other responsible official. A valuable feature of the book is the digest of state-highway specifications for water-bound macadam and telford, bituminous, brick, concrete and gravel roads. Much space is given to highway bonds, and there is a long series of tables for use in computing sinking funds, annuities, etc. Some idea of the extent of the good-roads movement may be gleaned from the fact that over 40 pages of the book are devoted to listing the various road-improvement associations—national, state and local.

Some Municipal Statistics

GENERAL STATISTICS OF CITIES: 1915—Including Statistics of Governmental Organizations, Police Departments, Liquor Traffic and Municipally Owned Water-Supply Systems in Cities Having a Population of Over 30,000. [Prepared under the supervision of Starke M. Grogan, Chief Statistician in Charge of Finance and Municipal Statistics; Arthur J. Hirsch, Chief of Division; and Lemuel A. Carruthers, Expert Special Agent.] Washington, D. C.: Bureau of the Census, Samuel L. Rogers, Director. Cloth; 9½x12 in.; pp. 185; one map.

For promptness of publication compared with many earlier Census reports this volume deserves commendation. The figures for the 204 cities and towns included are for department years ended from July 1, 1914, to June 30, 1915. True, this makes some of the figures nearly two years old when published (about May 1), but with such a variety of fiscal years as prevails and all the other difficulties hindering the collection of municipal statistics this date is about as early as could be expected. It should be mentioned, however, that promptness has been aided by limiting the contents to the four topics named in the subtitle.

Under governmental organization the readers of these columns will care most for data on the commission and commission-manager plans and for salaries paid to city engineers.

The water-supply statistics include date built or bought and estimated value of system; sources and modes of supply; kind of power used for pumping; kind, amount and cost of water purification; miles of mains; number of fire hydrants and meters; per cent. of water metered and per capita consumption. In addition, flat and metered schedules of water rates are given for the 155 cities owning their works.

Considering the limited range of the water-works statistics, it is a pity that some relatively useless figures are given. Of what importance are the figures giving number, depth and diameter in inches of wells? Of more possible value is the separate presentation of four columns of figures for coagulation; but space and labor could have been saved by a simple statement that all water passing through mechanical filters receives a coagulant, and a few footnotes would have taken care of the other instances of coagulation. A serious omission is the number of taps or services in the table that gives meters, per cent. of water metered and per capita consumption. This one omitted column would have been worth more than the three on wells and perhaps more than the whole seven to which exception has just been taken.

British Telephone Text

THE TELEPHONE AND TELEPHONE EXCHANGES; Their Invention and Development—By J. E. Kingsbury. New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. x + 558; 180 illustrations. $4 net.

If this book were seriously intended for sale in America, it would be carrying "coals to Newcastle," for it leans heavily on American publications for information on an American invention which, in its service, has been more highly developed here than anywhere else. The work is voluminous and not particularly easy reading, since the author has proceeded largely on the scheme of presenting extracts from original papers rather than to digest them for his own story. Such a work, it should be noted, is undoubtedly of much greater value abroad than American readers will readily appreciate—due of course to the greater familiarity here with, and the accessibility of, historical papers on the telephone.

The author gives first some of the attempts that preceded Bell's and then the details of his progress and final success. As might be expected, the larger part of the book is descriptive of the evolution of the modern exchange system—as individual pieces of apparatus and as assembled equipment. Finally the book discloses the development of rates, effects on industry and government control and ownership. Data on the telephone development of important world cities are appended, as of Jan. 1, 1914.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN PUBLIC HEALTH PROTECTION—By Henry Bixby Hemenway, A.M., M.D., author of "The Legal Principles of Public Health Administration," etc. Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 5x8 in.; pp. 283. $1.25 net.

CIRCULAR COVERED SERVICE RESERVOIRS—By William Morris, M. Inst. C. E. [Excerpt, Minutes of Proceedings of the Institution of Civil Engineers, Session 1914-15, Part I.] London, England: The Institution. Paper; 6x9 in.; pp. 15; 11 illustrations.

CONCRETE ON THE FARM AND IN THE SHOP—By H. Colin Campbell, Contributing Editor to the "Cement World" and "American Carpenter and Builder," Member of Editorial Staff of "Farm Engineering." New York: Norman W. Henley Publishing Co. Linen; 5x7 in.; pp. 149; 51 illustrations. 75c.

EXPLOSIVES FOR SHALE AND CLAY BLASTING—Wilmington, Del.: E. I. du Pont de Nemours Co. Paper; 6x9 in.; pp. 38; 31 illustrations.

FIRST REPORT OF THE COMMITTEE ON CIVIL SERVICE OF THE SENATE OF THE STATE OF NEW YORK, 1916—Albany, N. Y. Cloth; 6x9 in.; pp. 933.

FIRST ANNUAL REPORT OF THE PUBLIC UTILITIES COMMISSION, STATE OF MAINE (1915): Vol. I, Relating to Public Utilities—Augusta, Maine. Cloth; 6x9 in.; pp. 445.

INVAR AND RELATED NICKEL STEELS—Washington, D. C.: Bureau of Standards. Circular No. 58. Paper; 7x10 in.; pp. 68; illustrated.

PARKS AND PARK ENGINEERING—By William T. Lyle, Assoc. M. Am. Soc. C. E., Professor of Municipal Engineering at Lafayette College. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. viii + 130; 38 full-page plates. $1.25 net.

THE PORT OF BOSTON—By Edwin J. Clapp, Ph.D., Professor of Economics, New York University. New Haven, Conn.: Yale University Press. Cloth; 6x9 in.; pp. xii + 402; illustrated. $2.50 net.

THE PRACTICAL DESIGN OF STEEL-FRAMED SHEDS—By Albert S. Spencer. New York: D. Van Nostrand Co. Cloth; 6x10 in.; pp. xv + 163; 13 folding plates. $3.50 net.

PROCEEDINGS OF THE CITY MANAGERS' ASSOCIATION, 1915—Niagara Falls, N. Y.: O. E. Carr, Secretary. Paper; 6x9 in.; pp. 128. 15c.

Consists largely of personal experiences of the various managers in attendance. A list of some 80 city-manager cities with dates when the plan went into operation and names of the managers, is appended.

PROTECTION OF INDUSTRIAL PROPERTY: Monopolies Granted by Governments—By H. A. Toulmin, Jr., Member of the Ohio Bar. [Reprinted from the Virginia Law Review, December, 1915.] Dayton, Ohio: The Author. Paper; 7x10 in.; pp. 16.

QUANTITY OF GASOLINE NECESSARY TO PRODUCE EXPLOSIVE CONDITIONS IN SEWERS—By G. A. Burrell and H. T. Boyd. Washington, D. C.: Bureau of Mines. Technical Paper No. 117. Paper; 6x9 in.; pp. 17; illustrated.

A description of tests and notes on results appeared in our issue of Nov. 11, 1915, page 955.

REPORT OF PROGRESS OF STREAM MEASUREMENTS IN CANADA FOR 1914—Ottawa, Ont.: Department of the Interior of Canada, Irrigation Branch. Paper; 7x10 in.; pp. 508; illustrated. 35c.

STREET-NAME SIGNS—Bulletin 20, Engineering Extension Department, Iowa State College, Ames, Iowa. Paper; 6x9 in.; pp. 48; 38 illustrations.

A unique and interesting monograph, based on information and illustrations collected from all over the United States. Materials, design and color of lettering, supports, heights, locations and other phases of the subject are critically presented. Some cost figures are given.

VALUE FOR RATE-MAKING—By Henry Floy, Fel. Am. Inst. E. E., M. Am. Soc. C. E., Consulting Engineer. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 322; illustrated. $4 net.

Field and Office

Waterproofing Cures Expansion That Wrecks Roof

An interesting instance of a tile roof wrecked by thermal expansion and of unusually complete provisions (by waterproofing methods) against repetition of the trouble has been noted in the case of Laboratories A and B of the United States Department of Agriculture, Washington, D. C. Owing to faulty construction the roof tiles (red terra cotta) were laid without any regard to effects of thermal expansion and contraction (Fig. 1). As a result of the longitudinal force developed, the tile were crushed in many places; also the transverse expansion lifted the ridge tile, as shown in Fig. 3. Water penetrated the tile cover and ran down under the copper flashing of the cornice. The leakage into the building grew worse and worse in spite of employing every expedient short of rebuilding the roof. Finally in November, 1915, bids were asked for the waterproofing of the slab and relaying the tile, and contract was let to the Masonry Waterproofing Co., of Brooklyn, N. Y., for a trial section of about an eighth of the roof. This work was completed in December and has proved satisfactory under winter conditions. The sections will be watched through one summer; and if no trouble develops, the entire roof of both laboratories will be relaid similarly.

The tile were stripped off and cleaned; then the roof slab was cleaned to a smooth surface. (This stripping and the later covering were done over small areas so as to have no part of the roof slab open to the weather over night.) Next, a waterproof membrane was laid over the roof slab, the clean concrete being mopped with hot bituminous compound, and saturated sheets of cotton drill, 3 ft. square, being laid down with 2-in. laps. The compound was blended by the contractor so as to secure maximum cohesive and adhesive qualities. This particular use of a thin membrane of maximum plasticity was devised by Oscar Sheffield, Chief Engineer of the contracting concern ("Larutan System").

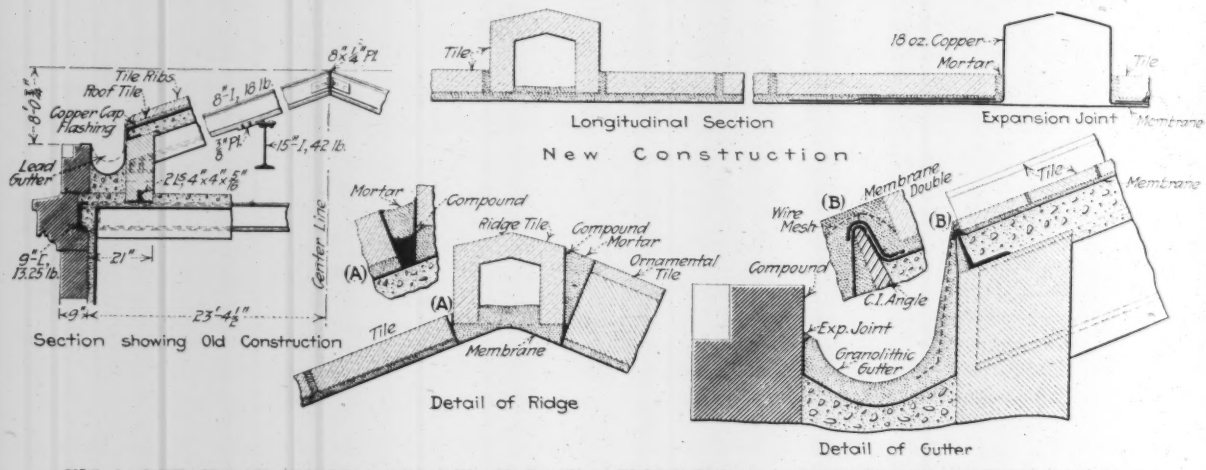
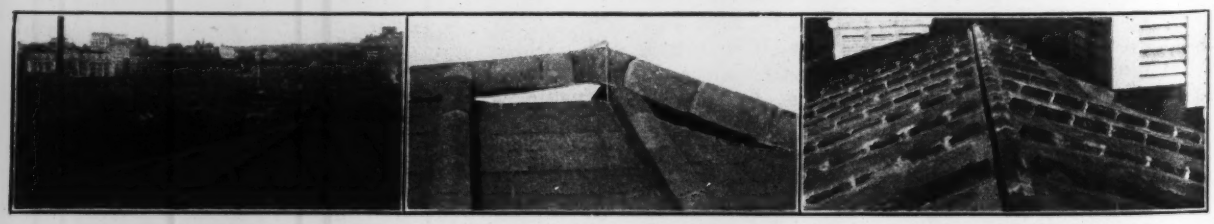


FIG. 1. DETAILS OF ORIGINAL AND RELAID ROOF; AGRICULTURAL LABORATORIES, WASHINGTON, D. C.

The membrane was carried over the angle at the eaves, down around the gutter and part way up the backing stone of the cornice, as shown in Fig. 1. The old copper gutter was removed and the membrane placed directly on the concrete and stone slabs of the gutter.

The tile was relaid, bedded in 2:1 portland-cement mortar, directly on the membrane. The joints were pointed with mortar colored to match the tile. The gutter membrane was covered with 2 in. of granolithic finish, reinforced with wire mesh on the vertical face. At the junction of granolithic gutter with the end of the membrane an expansion joint was used to preserve the seal.

Longitudinally every 50 ft. across the roof an expansion joint was made by replacing a line of ornamental tile with a false tile of sheet copper having flanges extending under the adjacent roof tiles and bedded on the waterproof membrane, as shown in Fig. 1. This



FIGS. 2 TO 4. ORIGINAL AND RELAID ROOF OF AGRICULTURAL LABORATORIES

Figs. 2 and 3 show some of the expansion troubles. Fig. 4 shows in the foreground copper false ornamental tiles

preserved the original appearance of the roof. One of the false copper tiles was similarly used as a sliding-sleeve joint cover in the ridge of the roof opposite each longitudinal expansion joint.

Where the roof and ornamental tile join the ridge tiles, the joint is sealed with compound and a grout plug, as shown in Fig. 1. Below each plug is a small reservoir of compound. As the roof contracts, the plug is drawn down into the bitumen; and as expansion occurs, the plug is forced upward—the seal being preserved under this movement.

Dynamite and Small Bucket Help Deep-Well Sinking

In sinking the deep wells from which Hibbing, Minn., gets its water-supply (as noted in *Engineering News*, Apr. 13, 1916, p. 688) so much difficulty was found with boulders blocking the well casings that a method was evolved of shattering the stones with dynamite and removing the pieces with a small orange-peel bucket in the well casing.

The wells are 24 to 36 in. in diameter, from ¼ to 1½ mi. apart, and are scattered over a glacial deposit of sand, gravel and boulders. The boulders are of hard granite; most of them run in size from 1 to 4 ft. in diameter and are smooth and round. Boulders are not encountered near the surface, as the first 25 to 40 ft. consists of fine sand.

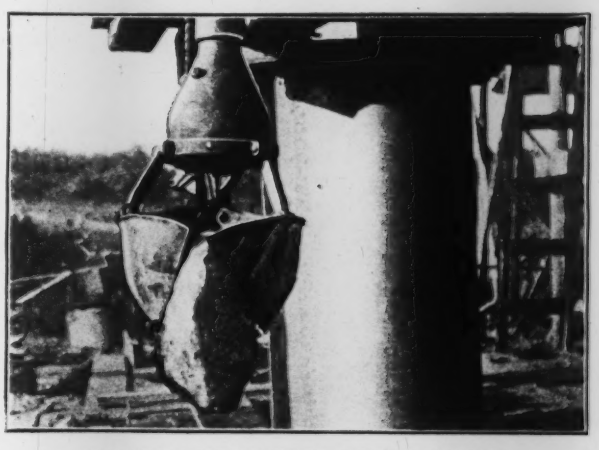
When the boulders were first met with, the drilling rigs were moved a few feet, in the hope of getting through the drift easily. Moving the derricks and resetting the rigs required two or three days, and frequently new boulders were struck.

The contractors then tried shooting. The casing screen was made of ⅜-in. boiler steel to withstand the blasts; on the bottom a ½x8-in. steel band was shrunk on. Occasionally the shots were too deep and heavy, and the screen was so damaged that it had to be pulled and drilling started with new material.

After much experimenting it was found most successful to place small shots against the boulders, an eighth of a stick of dynamite being used about 6 in. below the casing and as close to the rock as possible. Often it was necessary to shoot many times before a boulder would be shattered enough to be taken out through the casing by the bucket. Where a small boulder was not too far under the edge of the casing, it frequently could be shot out and turned over so that the bucket could grab it. For this work it was necessary to use a guide near the bottom to keep the casing straight and then to shoot all the way around the edge of the screen. Some days it would be necessary to set off 150 shots and the day's progress would be only 1 ft. sinking.

When the boulders were so large that an outside shot would have no effect, a hole was drilled in 5 to 8 in. and a small shot set off. A little dynamite thus used would break up any boulder in pieces small enough to be taken out through the casing.

In shooting, the casing was weighted down with a bin 8 ft. square filled with rock. The bucket was a 12-in. plunger orange-peel which had been previously used for bailing out sand, gravel and small stones. The dynamite was of 60% strength. The contractor for the well sinking was the Lane & Bowler Co., of Houston, Tex.,



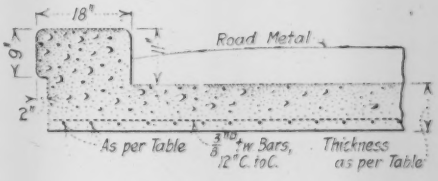
ORANGE-PEEL BUCKET WITH BOULDER
Boulder 9x12x18 in. Depth 45 ft. Casing 24 in.

which firm furnished the well and pumping equipment. Burns & McDonnell, of Kansas City, Mo., handled the engineering features of construction.

Flat-Slab Highway Bridges; Ohio Standards

Concrete-slab bridges of 2 to 20 ft. span on state-aid roads in Ohio will in future be built according to the sketch and table given herewith. The width on which wheel loads distribute is defined by a formula stated in the notes following the table.

STANDARD DIMENSIONS AND REINFORCEMENT FOR FLAT-SLAB CULVERTS AND BRIDGES
(Ohio State Highway Department)



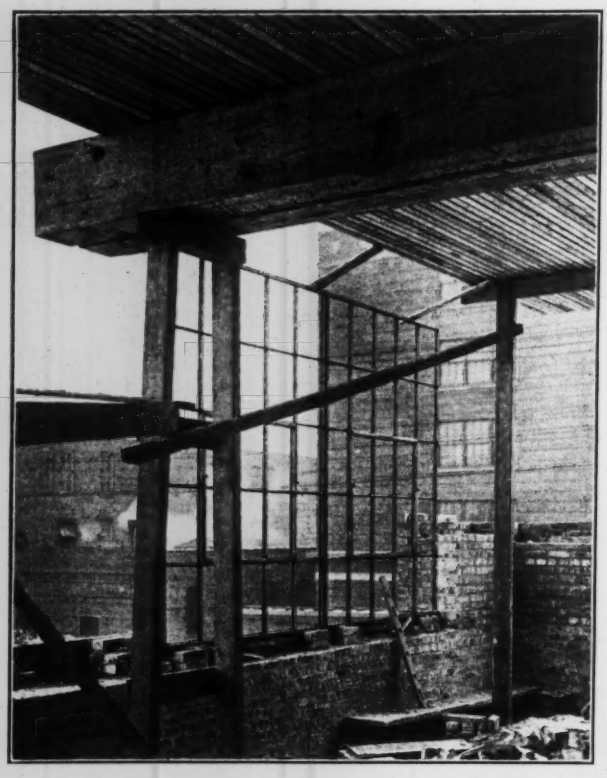
Span, Ft.	Thickness, In.	Spacing of Bars, In. ½ In. Sq.	⅝ In. Sq.	¾ In. Sq.	⅞ In. Sq.	Moment, 1,000 Lb.-Ft.
2	5	6½	...	...	...	2.06
3	6	6	...	...	...	2.82
4	6	5	...	...	...	3.38
5	7	5½	...	...	...	3.80
6	7	5	...	...	...	3.99
7	8	5	7½	...	...	4.74
8	8	4	6½	...	...	5.52
9	9	4	6½	...	...	6.45
10	9	3½	5½	7½	...	7.32
11	10	...	5½	7½	...	8.40
12	10	...	5	7	...	9.38
13	11	...	5	6½	...	10.63
14	11	...	4½	6	...	11.69
15	12	...	4	6	8	13.15
16	12	...	...	5½	7½	14.35
17	13	...	...	5½	7½	16.03
18	13	...	...	5	6½	17.34
19	14	...	...	5	6½	19.28
20	14	...	...	4½	6	20.75

Assumptions: Unit stresses—Concrete, 750 lb.; steel, 16,000 lb. Loads—Dead-load = Weight of slab + 100 lb. per sq.ft.; Live-load = 15 tons on two axles 10-ft. centers 6-ft. gage, two-thirds load on rear axle; Impact = ⅓ live-load. Distribution: p = (42 — 4S) for spans of 6 ft. or less, and p = (20 — 0.4S) for spans greater than 6 ft., where p = percentage of one wheel-load which is considered to be carried by 1 ft. width of slab as a concentrated load at midspan, and S = clear span in feet. Bars are to be placed two diameters from center of bar to bottom of slab.

The table was drawn up by John R. Chamberlin, bridge engineer of the State Highway Department, under Clinton Cowen, Commissioner of Highways. It is one of a considerable number of standard sheets for roadwork. This particular table was adopted during the past month.

Erecting Mill-Construction Buildings in Winter

The erection of a building of the timber mill-construction type during the winter is shown in the accompanying view, the placing of the heavy timber framing and floors being carried on even when the weather was too cold for laying brick. The columns and girders for the second and third floors were braced in place, and the laminated flooring was laid upon the girders. The view shows the braced temporary supports at the ends of the girders and the temporary plate installed to carry the ends of the



ERECTING THE TIMBER FRAME OF A MILL-CONSTRUCTION BUILDING IN ADVANCE OF THE BRICK WALLS

flooring. The structure is a four-story building for the Central Bay Manufacturing Co., the architect for which was S. Scott Joy, of Chicago. It is one of several buildings of the timber mill-construction type which have been built at Chicago during the past winter.

Sewer and Street Work for New Chicago Union Station

The construction of the new union station at Chicago involves a large amount of preliminary street and sewer work, most of which is done under difficulties incident to busy city streets. Three views of interesting portions of this construction work are shown herewith.

Fig. 2 is a view of the construction of the 12-ft. horseshoe-section outlet sewer, which has to be carried around the station property instead of running across it to the river (*Engineering News*, Feb. 3, 1916). The view is looking north in Canal St., and at the left is the Chicago & Northwestern Ry. terminal station, at Canal and Madison St.

A revolving steam shovel in the trench is making the second cut for the grade of the bottom of the sewer and is loading the material into dump wagons on the street. During part of the work the loaded wagons were driven back over the completed section of the sewer to finish the backfilling and raise the street to its new grade. This part of the street (at the left) is shown at the old grade, but the sidewalk is on the new grade. This sidewalk forms the top of a public-utility gallery (*Engineering News*, Dec. 16, 1915). The concrete wall at the right is the boundary of the station property and was built in a narrow deep trench before the excavation of the trench for the sewer.

Concrete is mixed at a plant north of Madison St. and spouted through a long suspended chute (*Engineering News*, Feb. 3). For some portions it was diverted into branch pipes leading to the forms; for other portions it was delivered to a hopper for loading wheeled carts that were dumped into the funnel heads of flexible telescope pipe chutes. When the work was near the concreting plant, the elevator bucket dumped directly into one of these pipes, which was extended up the tower, while its lower end connected with an inclined open chute or trough.

Where the sewer crosses under Madison St., drifts were driven and heavy timbering put in, with steel girders to carry the roadway and car tracks. The sidewalk was carried over the trench by an old plate girder laid on its side. The excavation of the core was done from one side, small steel dump-cars removing the material and dumping it as backfill over the completed part of the work.

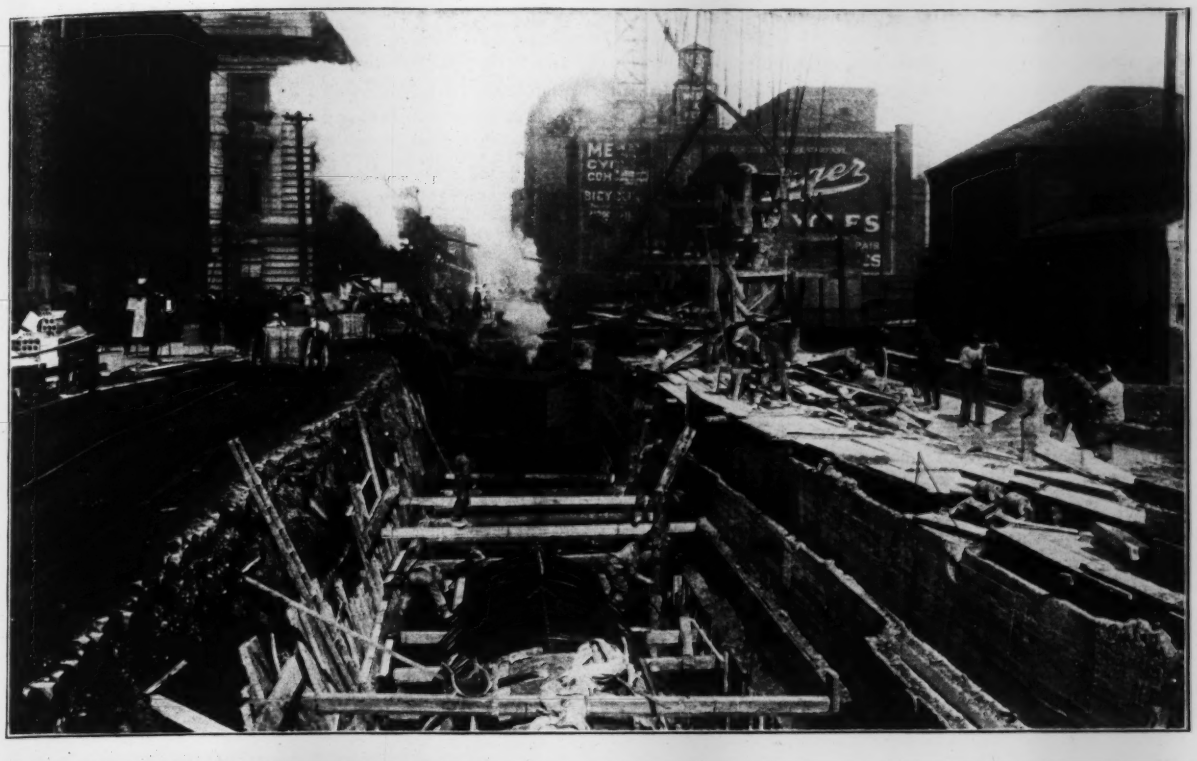
At the right in Fig. 2, where the two men are holding the reinforcing hoop, is the top of an incline (parallel

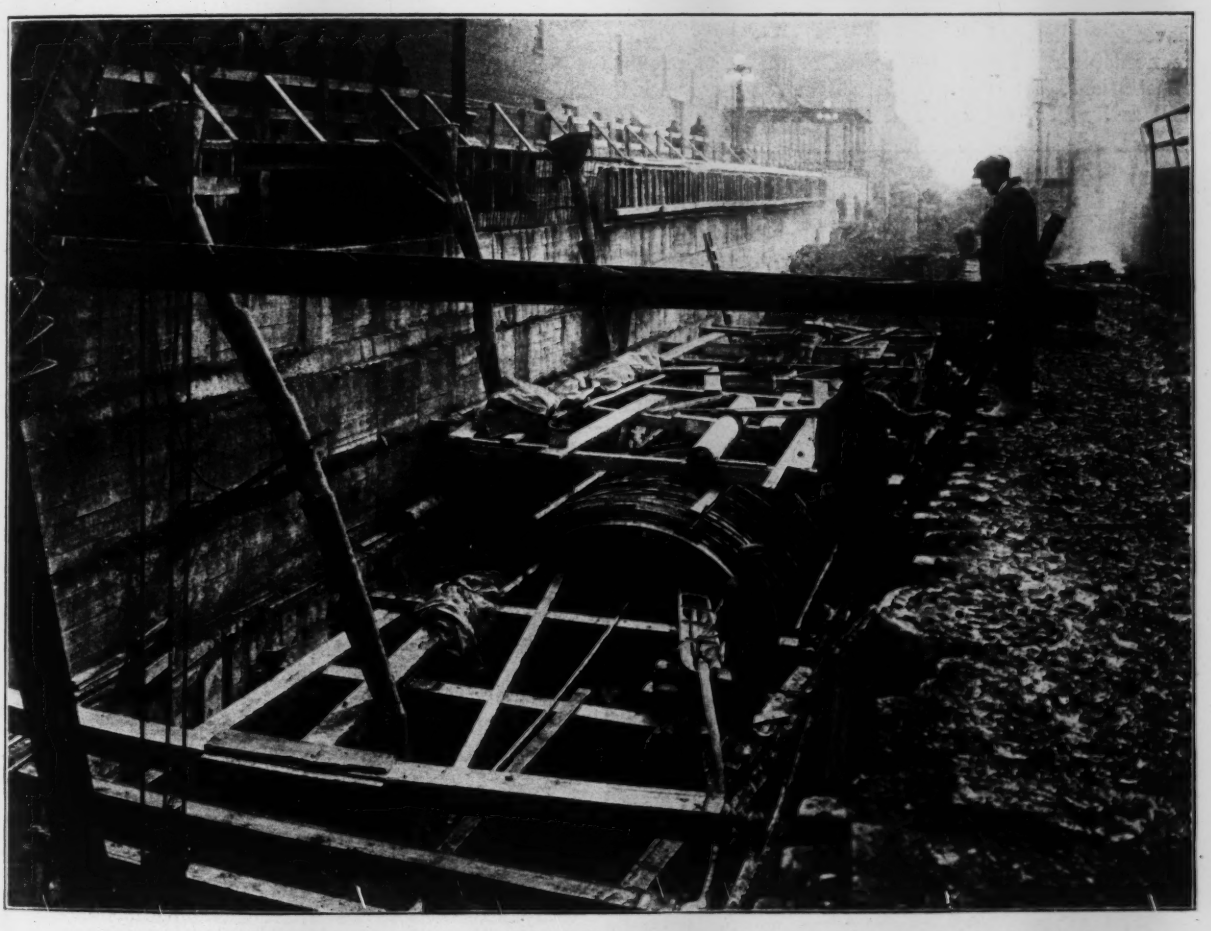
FIG. 1. RAISING THE GRADE OF CANAL ST., AT THE UNION STATION, CHICAGO

Roadway at old elevation; sidewalks and manholes at new elevation

with the street) leading down to the level of the railway tracks in the present union station. This is for express and mail wagons, and a temporary bridge was thrown across the cut to avoid interrupting this traffic.

Fig. 3 is a view of the same work looking south. The sidewalks are at the new elevation, that on the left being





FIGS. 2 AND 3. BUILDING A 12-FT. SEWER AND CHANGING THE GRADE OF CANAL ST., CHICAGO, FOR NEW UNION STATION

of plank and supported temporarily and that on the right being permanently located on top of the utility gallery. The shelter over the sidewalk at the right is at a new and temporary baggage-delivery platform, with elevators in the sidewalk.

The street has now been filled to the new elevation at this point, with paved inclines in both directions to the old elevation, so as to facilitate the handling of baggage wagons during the construction of the station.

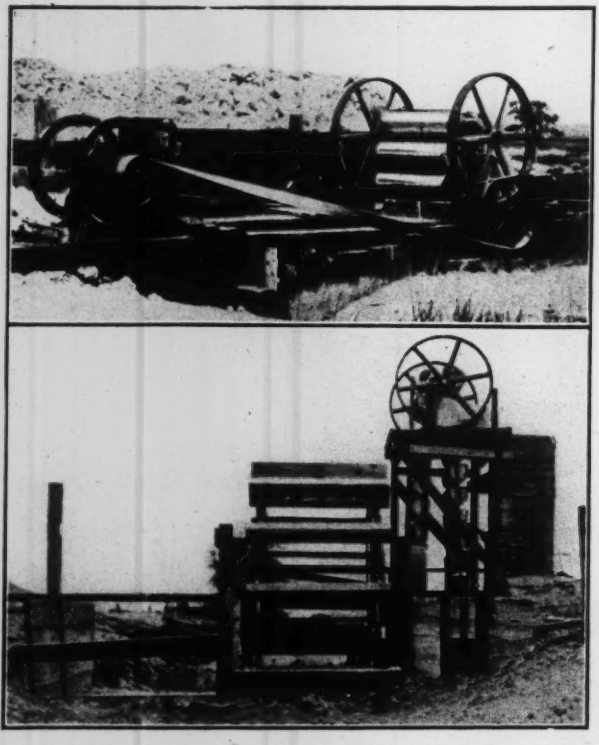
On the extreme left are the boom and dipper handle of the stream shovel, and between these and the backfilling the sewer is in various stages of construction. Along the concrete boundary wall are some of the telescopic chutes for concreting.

The sewer and utility gallery were built by the W. J. Newman Co., Chicago. The work was done according to the city's plans, but will be paid for by the Chicago Union Station Co., as it was necessitated by the construction of the station. Thomas Rodd, Pittsburgh, Penn. (Chief Engineer of the Pennsylvania Lines), is Chief Engineer of the company; A. J. Hammond, Chicago, is Assistant Engineer in direct charge of the work.

Chain-and-Bucket Lift for Irrigation Water

Water lifts of the chain-and-bucket type are used to a considerable extent in Western irrigation. About 800 such lifts, under the name "Famous Water Elevator," have been installed in the last few years by a Denver manufacturer. These lifts, shown in the accompanying illustrations, are made with galvanized-iron buckets, ball and roller bearings, and friction drive, in sizes of 250 to 1,000 gal. per min. capacity (requiring wells 4 ft. to 7 ft. in diameter). They have been made to operate with lifts as high as 135 ft. In one plant now in operation a 20-hp. gasoline engine, in the arid region of Colorado, raises 600 gal. per min. 135 ft.

Fig. 2 shows an interesting installation for raising water out of the low-level main canal into higher-level laterals. The power is a home-made undershot waterwheel at a small drop in the main canal. This device raises 450 gal. per min. to a 12-ft. elevation. Windmill drives also have been used to some extent.



FIGS. 1 AND 2. CHAIN-AND-BUCKET WATER ELEVATOR

Fig. 1 (Upper View)—Engine-driven unit on irrigation project. Fig. 2 (Lower View)—Elevator driven by home-made waterwheel

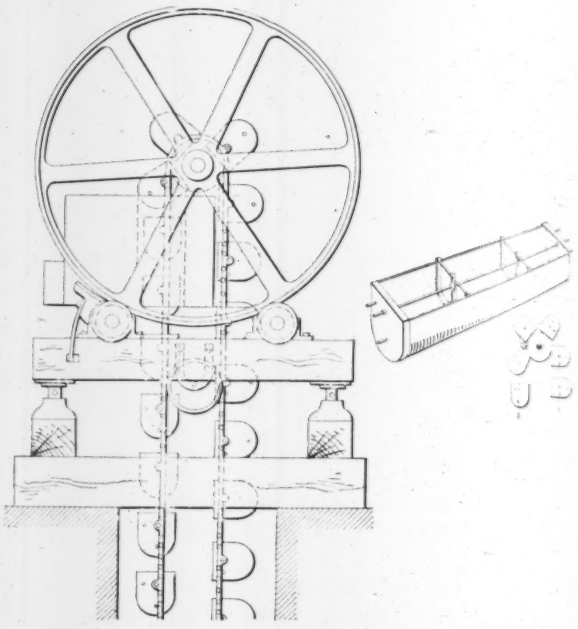


FIG. 3. DETAILS OF COLE WATER ELEVATOR

This machine has not been exploited for drainage pumping and contractors' use, although débris has been handled without serious trouble. The elevator is light and easily taken apart for transportation.

The device was developed by Henry Cole and certain features are patented. It is made by the Famous Water Elevator Co., Denver (A. J. Cole, General Manager).

Lining Ditches with Cement Gun

On many Hawaiian sugar plantations where irrigation is a necessity the soil conditions are such as to require lining of ditches. In this work much experimenting has been done with various kinds of plaster and cement linings, among the latter being gunite, or cement mortar applied with the cement gun. In a report to the Hawaiian Sugar Planters' Association, A. W. Collins, engineer of the Maui Agriculture Co., gives some data on the cement gun for such service.

The ditches are first roughly trimmed and ordinary chicken wire then fastened to the sides and bottom with nails or staples. Where the surface is uneven, it is brought to plane by mudding. On this wired surface a thin coat of mortar is applied with the cement gun.

A specific case of such work is described by Mr. Collins as follows:

We have finished 2½ mi. of open ditch and three short tunnels, their respective lengths being 250, 400 and 750 ft. The outfit has been entirely satisfactory, and very good results

have been obtained. On our larger ditch we have averaged about 100 ft. per day, a running foot being equivalent to 18 sq.ft. All the labor on the job has been under contract, varying on this larger ditch from 15 to 20c. per lin.ft. This cost covers mudding where the section is uneven, wiring, man for nozzle, men mixing sand and cement and supplying the gun, a helper for the engine and all labor for moving the outfit.

The tunnel work has given us a good line on what is possible with the gun. In all three tunnels the engine and gun have been at least 100 ft. from the end of the tunnel. This in the long tunnel would make an 850-ft. delivery pipe or hose from the gun to the nozzle. Working at this distance, however, diminishes the output considerably, since the air motor cannot be run wide open, as when working nearer. This means less material delivered to the discharge pipe and consequently less work.

The following is the record of complete cost of work for a period of five weeks on a ditch of 18 sq.ft. of surface:

Labor, 2,600 lin.ft. at 15c.	$390.00
Cement, 270 bbl. at $3.50	1,295.00
Sand	100.00
Gasoline, 870 gal. at 22c.	191.40
Wire mesh, 5,200 ft. (6 ft.) at 4c.	208.00
Wire mesh, 2,600 ft. (4 ft.) at 3c.	78.00
Superintendence	150.00
Incidentals	100.00
Cost of 2,600 lin.ft. = 46,800 sq.ft.	$2,512.40

New Idea in Windows

A novel scheme in metal-window construction is to be noticed in the equipment being installed in the new Frick Building at Pittsburgh. The new window cannot be called double-hung, casement, pivot or balanced. It is a distinct departure from all previous designs.

The window is framed of special rolled-steel sections, as shown in Fig. 2, and is divided vertically into two equal parts. The halves are hinged vertically, and each half is supported at top and bottom by a swinging arm pivoted on a stiff vertical center bar. A single hinged handle on one of the leaves enables a person to adjust the window to any open position, and this handle hooks over a catch on the center bar to lock closed. There is a simple notched plate on the sill frame swinging over to engage the corner of one leaf and to hold the window in any position. There are no loaded sliding parts except the hinges, and the window is easily operated.

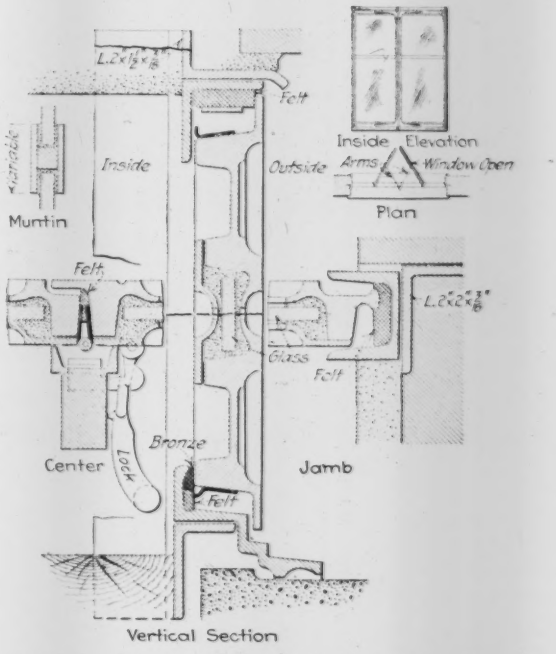


FIG. 2. DETAILS OF THE BROWNE WINDOW

FIG. 1. A NEW IDEA IN WINDOWS

The advantages in securing maximum light and air and the ease of cleaning both sides of the glass are apparent. By the general use of heavy felt packing strips and care in shaping the rolled-steel sections the window has been made highly weatherproof.

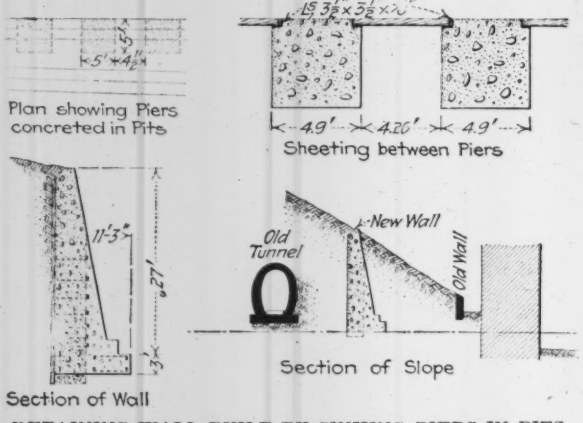
A sample window is reported to have successfully passed the fire-and-water test of the Underwriters' Laboratories. Various wind, rain and dust tests have been made—notably in the Woolworth Building tower in New York City and by the architects of the New York Telephone Co.—and the reported results are superior to those secured with familiar designs. This window is the invention of R. B. Browne, of Richey, Browne & Donald, Inc., ornamental metal workers, Maspeth, L. I.

NOTES

A Ballasted Track on a Paved Viaduct is an emergency arrangement employed by the Des Moines City Ry. for crossing the Seventh St. viaduct at Des Moines, Iowa. It is a reinforced-concrete structure with brick paving between the curbs, but the concrete floor was built with slots, or recesses, for tracks to be laid in future. The South Des Moines cars crossed an old wooden bridge at First St., but this was carried away by the ice in February. To reopen communication, a single track was laid over the Seventh St. viaduct, being placed at one side of the roadway, with ballast just clear of the gutter. The cinder ballast, retained by plank curbs, carries a track construction of ties and T-rails. It is intended to lay the permanent double-track line over the viaduct this year. This is part of extensive improvements con-

templated, including a few extensions. The greater portion of the track in the business district is to be relaid, and the contract for this work has been let to the North American Construction Co. W. L. Wilson is Chief Engineer for the Des Moines City Railway Co.

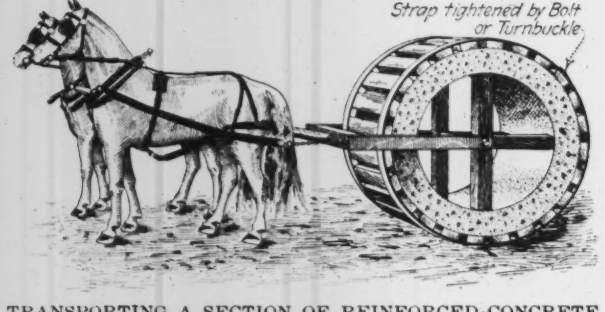
Economical Method of Building Retaining Wall—A novel method proved cheapest for building a difficult retaining wall at Loschwitz, near Dresden, Germany, according to a description by Professor Böhm, in "Armierter Beton" of March, 1916. The hill is compact sand, but in driving a tunnel through it some 20 yr. ago there were troublesome slides, and on this account it was thought risky to excavate for the new 30-ft. retaining wall and backfill behind the finished wall. Heavy shoring would have been required with this method of construction, evidently. One of the bidders proposed to construct alternate sections of the wall in sheeted pits before excavating in front of the wall, and his bid under this method proved low. Pits 5 ft. square were dug as sketched, 4½ ft. apart, with horizontal sheeting carefully placed as digging proceeded. These pits were concreted, the sheeting being removed as the concrete was rammed in. The piers so built went down a foot or two below the general footing level of the wall. Angle-iron chases were concreted in the rear corners of the piers. Then the ground in front was excavated and the piers braced by rakers. Then the earth between piers was dug away, breast-boards were set in the chases of the piers to hold the face, and at the same time all voids back of the boards were packed with earth. Thereupon front forms were



RETAINING WALL BUILT BY SINKING PIERS IN PITS

set up, and the wall was concreted. The new concrete was bonded to the piers by roughing the contact faces of the old concrete and by placing some horizontal reinforcement, as sketched, tied back to the angle irons by rods which were put under initial tension by wedges. E. H. Metzner was the contractor who devised this method and carried it out.

Transporting Reinforced-Concrete Pipe by Rolling—In the double-tracking of the Atchison, Topeka & Santa Fe Ry., Coast Lines, from Albuquerque to Seligman considerable reinforced-concrete pipe in sizes 24 to 48 in. in diameter was used for culverts. The grading work was done by contract, but the culverts were furnished and placed by the railway company. Much of the second track is on new location, distant from the old line. Handling the heavy 4-ft. sections of 48-in. pipe over mountain roads to get the culverts in place ahead of the grading was a problem. The smaller sizes were handled by wagons, but for transporting the large pipe a more feasible method was devised by V. C. Proctor, General Foreman of Bridges and Buildings, who was in charge of the work. The sections of pipe were cleated, as shown in the accompanying sketch; the cleats were held at the ends by means of two steel bands or straps tightened by turnbuckle or bolt. Axle stubs were inserted in the ends and a wagon pole was attached. A pair of horses or mules was hitched to the pipe, and it was easily rolled over steep mountain roads without receiving the least injury.

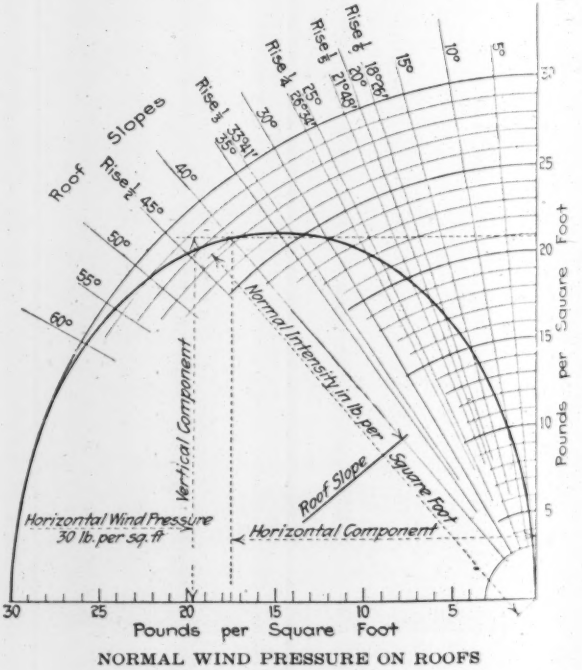


TRANSPORTING A SECTION OF REINFORCED-CONCRETE PIPE OVER MOUNTAIN ROADS

Rat Guards on Ship's Cables—The illustration shows how the mooring lines of ships docking in New Orleans are protected against the danger of being used as roadways for rats, which may carry plague or similar diseases from tropical countries. A city ordinance requires that ships from such ports must place guards on their mooring lines in such way as to prevent rats from jumping to the dock. The rat guards shown in the picture are of galvanized iron, one being strung over each rope.

RAT GUARDS ON SHIP'S MOORING LINES

Chart for Wind-Pressure Formulas—A polar coördinate chart similar to the one published on p. 327 of the Feb. 17 issue of "Engineering News" has been used for some time in the drafting room of R. A. Skelton & Co., Moorgate Station Chambers, E. C., London, England. This chart, reproduced herewith, is based on Duchemin's formula for 30 lb. per sq.ft. on a vertical surface, stating proportional values for other pressures. The vertical and horizontal components of the normal pressure can be read directly by means of a square.



NORMAL WIND PRESSURE ON ROOFS

Editorials

Old Fire-Protection Truths Once More Emphasized

In fire-protection work it is not nearly so hard to know what to do as to get the people to do it. Many fundamentals have been established and constantly repeated demonstrations should prove their truth. Unfortunately—as in the human parallel—experience must be personal. The boy does not learn from his father's mistakes. Each city must go through its own ordeal by fire.

The disastrous conflagrations of March 21 and 22—noted elsewhere in this issue—ran true to form. In no one of the three cities laid waste could the inspecting engineer point out any lesson which had not already been emphasized in some previous holocaust; in each one of the three there were long known defects, the correction of which would have prevented or reduced the fire loss.

The three fires had more in common than the date of their occurrence. They were all in mixed residence and business districts; in no one was there any great congestion of buildings; in no one was a lack of water the main cause of the spread of the fire; in all there was a high to violent wind blowing which in each case carried brands onto near or far shingle roofs, thus contributing more than any other factor to the spread of the fire.

In cities of the age and size of Nashville and Augusta universal fireproof construction of the best type cannot be expected. It will only be an occasional building that will resist or even contain an inside fire discovered too late. But in the light of experience it is not too much to expect that the conflagration hazard—the danger of communicated fire—will be reduced by the easy precaution of preventing shingle roofs and open foundations. Frame walls are dangerous, of course, but they do not offer the easy lodgment of brands of the roof or the unobserved floor ignition of the open foundation.

All of this is an old story to the fire-protection man, as are the other facts brought out in the three Southern fires—such things as the loss of foreign engine efficiency due to non-uniform couplings, the uselessness of incomplete fireproofing, and the impediment of a cotton-bale clogged street. Possibly the coincidence of the lessons may be impressive and add emphasis to long established truths.

Triple Expansion Still Ahead

Tests of a 30,000,000-gal. centrifugal water-works pumping unit in Montreal were reported in *Engineering News* of April 27, apparently showing a duty equal to that of the best triple-expansion pumping engine. Such an attainment was then supported by the reported data, but now the manufacturers of the unit state that they did not claim the attributed achievement; the trouble was that their computations of "duty" did not agree with the previously accepted practice of reporting water-works engine trials.

The reports received on tests of this unit showed a duty of 168.3 ft.-lb. per 1,000 lb. of steam (140° gage and 100° F. superheat). In accordance with recognized practice this corresponds to gross heat input. Deducting the heat rejected by the turbine as well as the somewhat meager data in this case permitted, the net duty seemed to be about 168 ft.-lb. per million B.t.u., which would have been a little better than the Bissells Point engine in St. Louis had done. For commercial reasons, it is stated, the makers reported a "duty" per 1,000 lb. of steam after crediting the unit with an amount of steam corresponding to the heat rejected, so that their figures are not what the term implies in accordance with standard practice. The reported figures, therefore, meant not the duty per 1,000 lb. of steam supplied under contract conditions, but an impossible hypothetical duty based on utilizing the entire heat in the steam. The heat used by the auxiliaries was retained in these figures.

The employment of such a basis and the quotation of such figures should be discouraged. No matter how plain is the warning of the true nature of the quoted duty, sooner or later the explanation will be lost. Then serious misinterpretation will result, as in this case. The confusion induced by such undesirable and unnecessary practices is just what it was aimed to eliminate by the American Society of Mechanical Engineers' universally accepted code for pumping-engine tests. That code should not be lightly departed from.

The proper figure for the Montreal unit now appears to be 134,000,000 ft.-lb. per million B.t.u.—although we have not had access to a log of the tests and are unable to further check the makers' statement. This figure is to be compared with 166,720,000 ft.-lb. for the Bissells Point engine. The triple-expansion reciprocating pump still leads the turbine-driven centrifugal.

Nuisance Control for Health Instead of Sentiment

A large part of the efforts of many boards of health, local and state, is devoted—or sacrificed—to attempts to prevent nuisances having no relation to public health. To divert local boards from useless nuisance work and to guide or if need be force their energies against nuisances that have a vital relation to health and disease, the State Department of Health of New Jersey has just adopted, as a part of its new State Sanitary Code, a half dozen short, clear regulations, printed on another page of this issue.

The first regulation is a prohibition against maintaining "anything whatsoever which is a hazard or a danger to human health." This may sound as futile as it is broad, but subject to the unescapable rule of reasonableness by which all health regulations must be tested it may prove to be a powerful wide-ranging and far-reaching weapon of defense.

The next regulation is the most important one of the six. It prohibits maintaining a dangerously polluted water-supply, used for drinking or household purposes. It covers not only private wells but also all other sources of supply, including public water-supplies. If the city owns the water-works, the duty to furnish pure water is on it. If the works are privately owned the duty is both on the company to supply pure water and on the local board of health to see that the company does so.

The other regulations prohibit the maintenance of privies, and the disposal of human excrement and of sewage in such a way as to endanger water-supplies, and also prohibit various conditions which produce fly and mosquito larvæ.

All the regulations are framed with a view to enforcement throughout an entire state having a great diversity of population, industry and wealth. They constitute a minimum to which all parts of the state must conform but the law under which the State Sanitary Code was framed and will be enforced permits local boards of health to go as far beyond these minima as their judgment and courage may permit. This applies to the entire Sanitary Code now being framed, of which the nuisance sections already adopted are but a very small part.

These nuisance rules may seem woefully scanty to some but they go to the very heart of the matter so far as real health-protective work is concerned and are broad enough to accomplish marvels if intelligently and fearlessly enforced.

One of the Joys of Serving the Great Public

A committee of the New York Legislature, headed by Senator Thompson, of Middleport, has been for some months engaged in investigating various matters in connection with the New York subway construction. Some of the methods it has used in carrying on this investigation deserve severe criticism. A good illustration is the questions which were asked of Alfred Craven, Chief Engineer of the Public Service Commission, when he was placed upon the stand. With an honest search after the facts no one could find fault, but when the questions are asked in such a way as to by innuendo reflect upon the character of the witness, the investigation becomes no longer a judicial proceeding but a machine for perpetrating serious injustice.

The attacks of the committee upon Mr. Craven are particularly unfortunate because Mr. Craven has a record of 32 years of continuous service for the City of New York, and has not merely an unsullied record but has served in situations where his fidelity to his trust has been of enormous value to the city.

Some of the older members of the profession will recall the investigation in connection with the construction of the new Croton Aqueduct, as it was called when it was built in 1884. On some of the sections of that work the contractors instead of filling in with solid masonry behind the aqueduct lining as specifications required, left voids there large enough to take in empty cement barrels. Mr. Craven was the division engineer on the aqueduct work. He was one of the men on the engineering staff whose honesty was unquestioned and who was one of the chief reliances of the Fassett Investigating Committee in exposing the frauds. As a result of the revelations of this investigation, the late Abram Hewitt, then Mayor of New York, persuaded the Governor of the State to call an extra session of the Legislature and passed a bill putting the old aqueduct commission under which the frauds had been perpetrated out of office. A new commission, appointed by Mayor Hewitt, was put in charge of the completion of the work and to make good the defective work, and Mr. Craven was one of the few engineers retained by the new commission. The contractors who had been responsible for the defective work were obliged to pump grout in back of the linings until all voids were filled. It was due to Mr. Craven's honesty and fidelity to his trust that the defective work was discovered in time to compel the contractors to make it good, and the city was saved at least $6,000,000.

There are other instances in Mr. Craven's long service to the city where his fidelity and integrity have been of the greatest value to the city. The engineering profession may properly resent gratuitous attacks upon the character of its eminent members.

Beginning Federal Expenditure for River Regulation

All the work thus far done by the Federal government on the rivers of the United States has been done ostensibly for the benefit of navigation. If the Humphreys bill now before the House of Representatives becomes a law, as now seems likely, it will mark the beginning of a new policy in river regulation. The Humphreys bill provides $45,000,000 for flood-control work on the lower Mississippi River, and $5,600,000 for flood control on the Sacramento. The bill does not directly appropriate these amounts, but it directs the Secretary of War to proceed with the work and appropriations to meet its cost will be provided in the Sundry Civil Appropriation bill next year and the years following.

The government has actually expended in past years a large amount of money to control floods in the Mississippi but the work has been done for navigation improvement. The Mississippi River Commission was created in 1879 and Congress has made appropriations for its work since that time of $85,680,000, of which about $29,000,000 has been spent on levee construction. The levee districts themselves have spent about $90,000,000 on levee work. It should be understood that the levee work is a necessity for the benefit of navigation as well as to protect the land back of the river from floods.

Engineers who have studied for years the problem of flood control on the lower Mississippi are agreed that the one effectual method of protecting from overflow the 20,000,000 acres of fertile bottom land along the course of the lower Mississippi is to establish a line of levees on each side of the river, from the head of the St. Francis basin on the north to the Gulf, and to make these levees high enough and strong enough to withstand the highest probable flood.

It is well known that the present levees are sufficient to withstand the high water of ordinary years. It was the record-breaking floods of 1912 and 1913 that aroused the Mississippi Valley to the importance of raising and strengthening these levees. The House Committee on Flood Protection, from the testimony of the engineers who appeared before it, conclude that the levees can be raised to the desired standard of height and sec-

tion in five years, with an expenditure of $6,000,000 a year from the Federal treasury supplemented by $2,000,000 a year from the levee districts benefited, in accordance with the terms of the Humphreys Act. In addition, a provision of $3,000,000 a year for bank revetment work is included, and the total annual appropriation was raised to $10,000,000 per annum in order that work might be planned for each season up to the full limit of the amount above named, and still leave a balance available in the annual appropriation sufficient for emergency work in case of a flood.

For many years the residents of the lower Mississippi River Valley have been appealing for a greater measure of government aid in the work of levee building. The greatest force behind the annual River and Harbor Appropriation bill for years has been the Mississippi Valley interests who urged appropriations for river improvements as a general policy in order that liberal appropriations might be given to the Mississippi River work. Evidently this repeated advocacy of Federal aid is at last to bear fruit.

The second part of the bill deals with flood control on the Sacramento River in California. It is probably little realized that the Sacramento has a flood volume exceeded by only three rivers in the United States, the Mississippi, the Ohio, and the Columbia. The maximum flow of the Sacramento is now estimated at 660,000 sec.-ft. Plans for the control of the Sacramento have been very thoroughly worked out jointly by state and Federal engineers. The work consists, in brief, of enlargement of the river channel and construction of four diverting weirs, at a total cost of a little less than $12,000,000. The State of California and the Federal Government have each contributed $400,000 already for this work. The appropriation above noted by the Federal Government supplies the remainder of its half. Besides this, a large amount has been and is to be expended by the land owners and municipalities to be benefited on levee construction and channel work. It is estimated that the total outlay by the property owners will eventually be in excess of $35,000,000, of which about half is still to be expended.

As might have been expected, the advocates of river control by reservoirs have been heard from, both in the discussions before the committee and on the floor of Congress. The Sacramento flood-control plan has been criticized as opposed to conservation, since it proposes to waste, through by-passes to the sea, flood waters which should be stored for beneficial use. At a hearing before the Flood Control Committee of the House, on Apr. 5, 1916, it was proposed that the floods of the Sacramento might be utilized "by conveying them in great flood water canals along the western slope of the Sierra Nevada Mountains to the south end of the San Joaquin Valley, and there utilizing them either through storage or by permitting them to soak into the ground so as to increase the subterranean water-supply."

The committee presents some interesting figures to test the practicability of this proposition. It assumes that such a canal would have to carry at least 200,000 sec.-ft., which is only a little more than one-third of the excess maximum floods of the Sacramento, which must be cared for outside of the river channel. Assuming a grade of 0.8 ft. per mile, such a canal would have to be 1,800 ft. wide and 20 ft. deep. If it took water from the Sacramento at Red Bluff and went no farther south than Los Palos, near Merced, a distance of perhaps 300 mi. on the contour line, it would, if run through level country, involve a total excavation of over 2,100,000,000 cu.yd. If only a small proportion of the excavation were in rock, the cost would exceed $700,000,000. The committee carried the computation still further, but this is ample to show the financial impossibility of such a scheme.

As to the proposition to store the Sacramento River floods in artificial reservoirs, the committee states that the engineers of the Army, the Reclamation Service, and the California State Engineering Department all agree that it is a physical impossibility to control the Sacramento River floods by storage reservoirs. In the discussion on Mississippi flood control on the floor of the House the advocates of reservoirs inquired why the floods could not be stored at their headwaters. The reply of Mr. Humphreys is worth quotation:

> We have gone very thoroughly into the proposition for reservoir control so far as the lower Mississippi River is concerned, and it has been the testimony of all the engineers who have examined it that it could not be done except by the expenditure of a sum so enormous that would stagger Congress to contemplate it.

The third section of the bill is especially noteworthy in that it lays down a general policy for the carrying on of surveys and investigations with reference to flood control on any river of the United States. According to this section, the Committee on Flood Control has authority to request the Board of Engineers for Rivers and Harbors to make examinations and reports on all works and projects relating to flood control in the same manner as for the Committee on Rivers and Harbors.

Why Increase the Civil Duties of the Army Engineers

The work done on the lower Mississippi under the provisions of the Humphreys bill noted in the preceding editorial is to be planned and carried out under direction of the Mississippi River Commission. The work done on the Sacramento is to be in charge of the California Débris Commission. It is the evident intent of Congress that all Federal work for flood control shall be carried on under direction of the Corps of Engineers. This action by Congress is entirely natural, for there is no other existing body of engineers to which it can turn with any confidence that the work will be done honestly and efficiently. On the other hand, it is obvious to every one that with the impending expansion of the army, the services of the engineer officers will be in urgent demand for military engineering work. The time is ripe, therefore, for the organization of a permanent body of civilian engineers for the government service in the field of river regulation. What is lacking is a thoroughly studied plan for the organization of such a body of engineers in such a manner as to insure high character and ability in the men composing it, freedom from partisan control and permanence of tenure.

There is every reason to believe that if the leading organizations in the engineering profession were to work out a practicable plan for such a civilian organization, it would have good chance of adoption by Congress. Unless and until this is done, however, Congress is pretty certain to continue its past policy of either utilizing the service of the Army Engineers or else leaving the heads of departments to secure engineering service as they think best.

Letters to the Editor

Co-operate, But to What End?

Sir—Under the head of "Coöperate, But to What End?" you discuss on page 812 of *Engineering News* for Apr. 27, 1916, the gathering of engineers at Chicago, Apr. 13 and 14. You say: "They came without tangible purpose, except to coöperate. They went apart with no more definite purpose: To coöperate, somehow, in the future. That is regrettable." I think that possibly you are not fully informed as to the real progress made.

To appreciate this we must bear in mind the mental attitude of the representatives of the various organizations of engineers. There has been and is not merely a desire to coöperate, but coupled with this a more or less indefinite fear that in entering upon such coöperation there may be involved some responsibility or danger to individual organizations. Because of this attitude of apprehension, it is necessary, first, to proceed with caution and to allay the fears of many otherwise well-informed men that somebody, somewhere or somehow, is trying to work out some scheme for ulterior purposes.

While a number of men who attended the conference had well-considered propositions, any one of which might have been adopted to mutual advantage, yet it did not seem wise to urge any one of these because of the too evident fear on the part of a respectable minority. They would have been confirmed in their fears had the majority of the members proceeded to take definite action along lines such as may be adopted after careful study. In the end more rapid progress undoubtedly can be made if for the first year or two the doubting Thomases are given ample time to consider all sides of the question.

It appears also that this fear had been intensified through the activity of some well-meaning friend who had taken pains to spread a rumor that the conference was called in the especial interest of one of the existing societies. While nothing of the kind was contemplated by any leader of the coöperative movement, yet there was enough erroneous information afloat to necessitate the use of considerable patience and tact.

A tangible result of this conference was to settle the first question asked in the call of Mar. 1, 1916; namely, "Is coöperation desirable, and is it practicable?" The answer given by the conference was strongly in the affirmative—that it is desirable and is practicable. The next step is to determine which of many lines is the most advisable to follow.

Farther along in your editorial you state: "By all means coöperate, but to what end? Let the end be apprehended clearly and made known!" This end is always in mind—namely, that of securing larger efficiency and economy in the activities of engineering organizations in order to bring about the largest service to the public through service to the members. More immediately, and leading to this end, are three important lines of work which were covered in the call and which should be kept always in view until substantial progress has been made. These three lines may be outlined as follows:

First, coöperation in securing wider diffusion of knowledge on engineering subjects. In this the results secured at Cleveland and elsewhere in publicity are instructive. This has led to better appreciation of the engineering profession and better service to the public. The excellent results already obtained and the possibilities of still larger achievement appeal to the members of nearly every organization. Through proper publicity the organization is strengthened, the interest of the members stimulated and the community benefited.

Second, better and more scientific study of employment of engineers, followed by the development, if possible, of a system which is more in accord with the intelligence of the engineering profession. Present conditions are not creditable to the assumed ability of engineers to deal with difficult matters. Many of the engineering associations have crudely conducted employment bureaus, some of which are doing good work; but the results are not such as to cause a feeling of pride of achievement.

The third and somewhat more remote end in view is a larger and better knowledge of legislative activity, not merely to promote legislation beneficial to engineers but to perform in a larger degree the duties of citizens, to anticipate needs and to turn the light of publicity upon schemes which the engineer from his knowledge of facts appreciates as unwise or harmful.

As stated by you, the opinion was expressed again and again to the effect that the individual engineer who turns to his technical society for counsel and help finds the society "static and supine, not to say torpid." This is a condition which need not exist and which can be corrected most effectively by frequent conferences and by full discussion of conditions and remedies. All agree with you, "There is logical basis for coöperation, if purpose backs the coöperation." Persons attending the conference surely believed that there is a purpose and that beneficial results are attainable.

I cannot agree with you that the Chicago conference failed to reach a diagnosis. While there may be a lack of agreement on details among persons who attended, yet on the part of many the diagnosis was fairly complete, and not one which it seemed wise to discuss at the present time, but rather to leave for a later meeting.

A volume could be written on the questions which you have raised, but the point I wish to emphasize is that the leaders of the movement for coöperation apparently are in agreement that large results can and will be accomplished through patience and tact rather than through trying immediately to urge the program of any one man or group of men. Let each and every organization be invited to consider these matters and to make suggestions.

It is probable that most of the plans presented by the different societies will be of a similar nature, and when finally adopted each organization will feel a proper interest in carrying out the program because of the fact

that it can take to itself a certain amount of credit for having initiated or suggested one or more of the details. For success, the movement must be from the ground up and not from any one man or group of men down or outward. The failure of so many attempts at coöperation has been largely because of neglect of this simple rule and because of the spread of the idea that the coöperation was initiated and sustained for the benefit of some one group or society rather than for the benefit of all.

F. H. NEWELL.

Urbana, Ill., May 3, 1916.

Co-operate, But in What Way?

Sir—In *Engineering News*, Apr. 27, there appeared a short article by Hugh J. Duffield, entitled "Should Engineering Societies Pass on Public Questions?" The case there involved shows the need of the sort of co-operation which was discussed editorially in the same issue under the title "Coöperate, But to What End?" What I have to remark also touches slightly on the letter of Albert J. Himes in the May 4 issue.

Mr. Duffield's communication deals primarily with the subject of engineering societies' passing upon public questions and thereby taking from the individual engineer some possible work and consequent remuneration and with it some of his standing. Mr. Duffield may be perfectly right in his criticism of the particular case in point; but if the society of which he speaks had been a real engineers' society and composed at least in its executive staff of men who were not only capable engineers technically, but also knew the primaries of professional ethics, such an examination as they made would not have been detrimental to the individual engineer connected with the work in question—unless that engineer had been doing inefficient work. Had he been doing inefficient work, it seems to me that the society would have been doing the engineering profession at large a kindness by putting the work upon an efficient basis. This would have been a case of the suffering of the individual for the good of the many.

This brings us to the editorial, "Coöperate, But to What End?" Societies that are voluntary organizations cannot coöperate to the fullest extent unless the individual members of such societies coöperate, and cannot coöperate in any case unless the executive officials of such societies coöperate. The line of demarcation between the individual effort and the society effort can seldom be sharply drawn, as one merges imperceptibly into the other.

> The lack of influence and power of the profession in the aggregate may be simply the resultant of the weakness and helplessness of each individual one of its members. If this is the case, then to strengthen the profession we must strengthen and help the individual.

This quotation from the editorial is only another way of saying what the writer has just said. Had the individuals making the examination of which Mr. Duffield speaks gone first to him or to whoever was originally in charge of this work and taken the matter up with him as a member of their own profession and as any regard for ethics would compel them to do, I cannot see how there would have been any friction in the matter. No engineer should be fearful of honest consultation.

I cannot understand Mr. Duffield's position when he states that "such a decision would have an influence not measured by the engineering ability of the investigators at all, but measured solely by the good or bad judgment of the men composing the committee." I cannot understand how the judgment, good or bad, of men composing a committee from an engineering society could help but be influenced by the engineering ability of those investigators. *One of the gravest faults of members of our profession in the past has been that many have tried to separate the engineer, so called, from the executive, so called.*

This has been done persistently, not only by engineers, but by those outside the profession. Many, many people carry the impression that an engineer is not and cannot be fitted to be in any manner an executive officer, that his judgment therefore as such cannot be relied upon and that he is to be believed or his opinion is to be asked only when his statements can be verified by the multiplication or division of figures or by the use of a right-line pen, a triangle or a pair of dividers.

"We engineers are in the grip of the times, and they are times of change," says the editorial. This is very true, and the closest kind of coöperation will not be too much to give the profession the standing that it should have as such. Without the standing the emoluments will not come. The engineering profession and the societies which represent it, including the civil, mechanical, electrical, mining and other groups, must not overlook the fact that it is not unethical nor unbusinesslike to boost for their own business; to throw back their shoulders and stoutly affirm that their profession and their work has a logical place in the scheme of things and that they are worthy of their hire. They must not accept longer the fallacy that to assist in the securing of good legislation or to assist in the killing of bad legislation for the profession is unethical. Until they work for themselves, no one will work for them. They must not be ashamed publicly to affirm that the members of their organization represent the men who can and are doing things; that their membership contains the best men in the world for any engineering project which mind can conceive; that the national engineering societies are the last word of authority on men and things engineering, whether it be construction, maintenance or operation.

> Complications of many different kinds arise to obstruct the activities of engineers, injure the good repute of the profession and make the individual's professional existence more precarious. . . . A leave-alone policy is a suicidal one. . . . It must take up each case and grapple with the difficulties.
>
> They are the large matters, as legislative over-riding of the engineer's claim to existence and recognition, destruction of the business basis of technical work by introduction of dispensary methods, engineering negligence in large matters to the discredit of the profession, usurpation of important technical functions by administrative officers to the injury of the public's and the engineer's interests, and the like. Smaller matters of the same and other kinds number legion. All have been left untouched—yes, have been deliberately ignored—by the existing societies of engineers. And all of them are beyond the power of the individual engineer to combat unless he has the support of a broadly conceived coöperating body that makes his interests its own.

These evils have not been touched by the national engineering societies because those bodies are not fostering the coöperation of individuals. The broadly conceived coöperating body will have no greater success unless it somehow effectively aggregates all the thousands of little personal actions that are useful and possible.

THERON M. RIPLEY.

Watertown, N. Y., May 6, 1916.

Tests of Corrugated Culverts

Tests of the collapsing strength of corrugated-iron culverts have recently been carried on by George L. Fowler, of New York City, for the Armco Culvert Manufacturers Association. Preliminary tests were made under hydrostatic pressure, and these resulted in the development of a formula for collapsing strength similar to that employed in the design of corrugated boiler furnaces. Sand-box test results were interpreted to show that increase in depth of cover decreases the effect of surface loading and that, after an indeterminate depth, added cover did not add to the load on the pipe. Mr. Fowler has furnished a copy of his notes on these tests and all the following information is abstracted from them.

Hydrostatic Tests

For the hydrostatic tests, pipes of 12-, 24- and 48-in. diameters were used in a closed cylinder. The depths of corrugation were ½ and ¾ in.—both pitched 2⅔ in. Longitudinal seams were double riveted with a pitch of 2⅔ in.; circumferential seams were single riveted on a pitch of 8 in. All sheets and rivets were galvanized. Four thicknesses of metal were tested—16, 14, 12 and 10 gage. At each end of each culvert an internal angle flange was riveted; these were faced to 8 ft. apart and drilled to match the casing bolt holes. The internal diameters were measured with calipers reading to 0.02 in.

It was found, first, that the support of the casing at the ends did not extend in more than two diameters. The tabulated results were as follows:

HYDROSTATIC COLLAPSING PRESSURE OF CORRUGATED CULVERT PIPE

Diam. of Pipe, In.	Gage	Depth of Corrugation, In.	Collapsing Pressure, Lb. per Sq.In.	
12	16	½	225	
12	14	½	275	
12	12	½	420	
12	10	½	450	
12	16	¾	360	
12	14	¾	380	
12	12	¾	490	
12	10	¾	630	
24	16	½	52	
24	14	½	75	
24	12	½	130	
24	10	½	160	
24	16	¾	100	
24	14	¾	100	(125)
24	12	¾	180	
24	10	¾	320	
48	16	½	15	
48	14	½	20	
48	12	½	33	
48	10	½	58	
48	16	¾	29	
48	14	¾	39	
48	12	¾	45	
48	10	¾	70	

In interpreting the results Mr. Fowler considered the effect of diameter, thickness of metal and depth of corrugation. Strength of pipe was taken to vary with the strength of material and (within the range studied) depth of corrugation. The effect of diameter empirically entered (1) the exponent of a divisor of the thickness-corrugation product and (2) a correction factor of a simple formula first deduced. The final formual was:

$$P = \frac{5{,}960CT}{2^{\left(\frac{D-12}{12}\right)}}\left(1 - 0.4 log \frac{D}{12}\right)$$

where

P = Collapsing pressure in pounds per square inch;
C = Corrugation depth in inches;
T = Thickness of metal in inches;
D = Inside diameter in inches.

Mr. Fowler, however, simplified this (by inspection of the United States boiler-furnaces rules, and for diameters of 10 to 24 in., metal thickness of 0.0625 to 0.141 in., and working pressures of half the collapsing strengths) to

$$Working\ pressure = \frac{34{,}000CT}{D}$$

which can be used in design.

Sand-Bed Tests

For testing the collapsing strength under sand pressure, a box was made with one side movable to secure widths of up to 7 ft. The height was enough to allow 1 ft. of sand below a 48-in. pipe and 2 ft. above. Three 100-ton jacks gave the load, on three platens 24-in. wide and reaching the full length of the box. Diaphragm dynamometers were placed on top of the pipe and on two floating planks in the box side. The sand was kiln-dried and sharp.

Arching of the sand under pressure was evident. In a preliminary-test box it was found that the lateral thrust rose to a maximum under a shallow depth and remained practically constant; with a slightly yielding bottom the sand arched to relieve the bottom of load which was carried by frictional resistance of sand against the box sides.

In the main tests, it was found that when the platen was wider than the pipe the pressure was largely supported by the column of sand over the pipe and less by the more yielding sand beyond the pipe walls. Then the load imposed on the pipe was greater than as if considered uniformly distributed by the platen.

The results exhibited the conveyance and distribution of sand pressures, but were not considered sufficient to warrant developing a formula for calculating culvert pressures. For instance, it was seen that the top pressure on pipe decreases with a given load placed on increasing depths of sand, but the proportional relations were not disclosed. The lateral pressures were low and no definite ratio was established. The lateral pressure increased rapidly from the top down to a point determined by the angle of repose of the sand and then decreased.

In some of the tests the platens were replaced by 8-in. ties, 22 in. c. to c. supporting rails laid on 4 ft. 8½ in. gage. The loading jacks bore on the rails. With the broad platens the tests had been stopped when the top of the pipe deflected 1 in.; with the ties the deflection of the pipe was slight (average 0.14 in.) when the ties had sunk into the sand. (From this, incidentally, it appeared that a given area would support a greater weight upon a sand bed if concentrated than if divided into small separated units.) The gross burden on the ties was considerably greater than on the platens (237,800 lb. with 24-in. pipe). The recovery of pipe shape was complete on removal of the load.

It was concluded that under the heaviest load that can now be applied to railway ties by any existing locomotive or car, a 24-in. 14-gage pipe with ½ in. depth of corrugation, and under 24 in. cover of dry sand, cannot be deflected beyond its elastic properties of complete shape recovery. The 36- and 48-in. culverts are held to be uncrushable under a cover equal to their own diameter. The weight of cover in a wide loose fill or bank is not so well supported as in a ditch and it was concluded that conditions of unusual severity might be induced which should be provided for by heavier metal.

Seventeen Millions Lost in Fires in One Day

By a remarkable coincidence the long period of freedom from large conflagrations in the United States was broken on Mar. 21 and 22 of this year by three destructive fires in widely separated sections of the South—at Augusta, Ga., at Paris, Tex., and at Nashville, Tenn. These fires started within 25 hr. of each other and the fire-fighting periods practically overlapped. Recently issued reports[1] by local fire-inspection bureaus show a striking similarity in the nature of the conflagrations and in the lessons to be learned therefrom. The main features of the fires may be briefly stated as follows, the data being separately given in the accompanying tabulation.

THREE CONFLAGRATIONS ON MAR. 21 AND 22, 1916

	Place		
	Paris, Tex.	Nashville, Tenn.	Augusta, Ga.
Fire started	Mar. 21, 5:30 p.m.	Mar. 22, 11:47 a.m.	Mar. 22, 6:20 p.m.
Length of fire	10 hr.	4 hr. 45 min.	10 hr. 40 min.
Area burned	264 acres	64 acres	160 acres
Buildings destroyed	1,440	648	682
Estimated loss	$11,000,000	$1,450,000	$4,250,000
Insurance loss	5,000,000	850,000	3,500,000

Paris, Tex.—The Paris fire started in a one-story frame, shingled-roof warehouse, in daylight on a hot, windy day. The flying brands soon communicated fire to adjacent shingle roofs in spite of a fairly good local fire department and much outside fire apparatus called in under its own power and by rail. On account of non-uniform couplings these latter were not of maximum efficiency. The fire was soon out of control and worked its way through the main residential and mercantile sections of the city. Of the destroyed buildings 704 were dwellings, 192 mercantile buildings, 522 small outhouses, and 22 public buildings; 73% had combustible roofs and 90% were of frame or iron-clad construction. The water supply did not have high enough pressure, but it is doubtful if this had very much effect except in local instances and in sprinklered buildings. Such sprinklered buildings where the water pressure was high enough were saved. Some reinforced-concrete buildings were in the line of the fire and the framework stood up admirably, but the lack of sufficient window protection resulted in interior gutting. An inspection of the reinforced-concrete construction also showed that in nearly every case insufficient protection had been provided for reinforcement in girders, for the steel was generally bare or its location clearly discernible though no water was applied to the members, showing the necessity of providing a protection of at least 2 in. of concrete for reinforcement in columns and girders. A very important fact is that shingle roofs help spread the fire.

Nashville, Tenn.—The Nashville fire started about noon in an unoccupied planing mill during a 44-mi. gale. In the immediate vicinity of the fire were mostly small frame buildings which soon caught and were destroyed in spite of the best efforts of the department. However, the important feature of the Nashville fire is that about an hour after it started the gale increased to 51 mi. per hr. and the burning shingles and flames of the nearly controlled fire were carried across an 1,800-ft. clear space and ignited other shingle-roof buildings in the center of a highly valued residence section in East Nashville. Here the speed of the fire was remarkably rapid, due first to the very high wind prevailing, and, second, to the light frame, open foundations and shingle roofs of the residence section. The fire was fought entirely by the local fire department, and the water service was apparently sufficient. The tabulation of the buildings burned is as follows: Frame with shingles, 159; frame with fire-resisting roofs, 180; brick with shingles, 1; brick with fire-resisting roofs, 79; frame, small buildings, 229.

Augusta, Ga.—The Augusta, Ga., fire broke out at 6:20 p.m., in a dry-goods store, which had been closed about 6 p.m. The wind was about 22 to 26 mi. per hr. and decreased during the progress of the fire. The building in which the fire started was a brick-wall, wooden-frame structure, five stories high, and known locally as a fire trap. The fire soon got beyond the control of the local company and companies from adjacent cities were called in. Great trouble was had in getting the foreign engines to work on account of nonuniformity of hose connections. The fire burned through business and residential sections, some of them the best in town. The residential section was mostly frame with shingle roofs, the business of brick mostly with metal roofs, but with many very old buildings. The water-supply was inadequate. Of the buildings burned 113 were brick, 569 frame; of these 541 were dwellings, 100 mercantile establishments, and 41 miscellaneous. The fire was undoubtedly carried by shingle roofs and by the frame structures. The fire fighting was obstructed by the great amount of cotton stored in the streets, a common practice in many Southern cities, which not only prevented the engines from getting to work but also helped the spread of the fire.

[1] Paris, Tex.; report of the National Fire Protection Association, 87 Milk St., Boston, Mass., and report of the National Board of Fire Underwriters, 76 William St., New York. Nashville, Tenn.; report of the National Fire Protection Association. Augusta, Ga.; report of the Southeastern Underwriters Association, Atlanta, Ga.

Gravel Roads in Illinois

For county work in gravel-road construction in Kane County, Illinois, the county supervisors have their own machinery. This includes a 40-hp. gasoline engine to operate a 3½-ton road grader (with 12-ft. blade), a portable screening and crushing plant, and a tank wagon. There is also a 5-ton motor-truck with 5-ton trailer, which distribute the road material and are used to move the crushing and screening plant from place to place.

In distributing the gravel all hauling is done over the gravel already laid, so that the motor truck operates as a roller. The material is placed in two courses, in order to get a thorough rolling. The truck wheels have steel tires, 10 in. wide on the front and 21 in. on the rear wheels. The loaded truck weighs about 14 tons, of which the rear wheels carry 70%. The truck and trailer stand under the storage bin to load.

When distributing, the bottom-dump trailer is first unloaded, this being done while it is in motion, in order to spread the material. It is then uncoupled and the rear-dump truck unloaded by tilting, after which it is turned around and coupled to the other end of the trailer for the return trip.

The portable screening and crushing plant has an output capacity of 200 cu.yd. per day. It consists of a rotary screen, a crusher and a 15-yd. storage bin, together

with a bucket elevator and two belt conveyors. To keep the height within limits convenient for transportation, the screen is mounted separately, instead of being carried above the bin. This plant was built by the Stephens-Adamson Manufacturing Co., Aurora, Ill.

The gravel from the pit is moved by scrapers and dumped into a hopper over the lower end of a belt conveyor that elevates it to the screen. From the screen the product of ⅛- to 1½-in. size is fed by a chute to the boot of a bucket elevator that delivers it to the storage bin. The oversize is delivered to the crusher beneath, the product of which (crusher-run) goes to the elevator and bin. Material finer than ⅛ in. is delivered to a second belt conveyor and discharged upon a waste pile.

For moving the plant, the motor truck is run under the bin, which is lowered upon it, the supports and other parts being placed within the body. The screen is loaded upon a wagon, the crusher has its own wheeled frame, and the various accessory parts are placed in the trailer. The motor truck hauls the trailer and tank wagon, while the tractor hauls the crusher and screen. G. N. Lamb, of St. Charles, Ill., is County Superintendent of Highways.

Columbia Engineering Alumni Dinner to Professor Burr

The alumni of the schools of engineering of Columbia University, numbering over 100, gave a dinner at the Waldorf Astoria in New York on Apr. 26, in honor of Prof. William H. Burr, who after 36 years' service as a teacher of engineering is to retire from the chair of civil engineering at Columbia at the end of the college year. Among the after-dinner speakers were President Nicholas Murray Butler and Public Service Commissioner Henry W. Hodge. Mr. Hodge was a student under Professor Burr and later began his work in bridge engineering as an assistant to Professor Burr in his private practice. The following extracts from Professor Burr's address are a valuable contribution to the discussion on engineering education:

I was trained as a student to the historic view of civil engineering as being the foundation of all engineering not military. In my student days the great specialties of the present time had scarcely been recognized, except that mechanical engineering had been formulated, but had not become full-fledged. I have adhered to that historic and fundamental view. Civil engineering is not a specialty, and the educational training required in qualifying for the practice of the profession should include the fundamentals of both mechanical and electrical engineering.

It is interesting to contrast some conditions of the present professional service to those which existed forty years ago or more. As a student in the most prominent and effective engineering school in this country at that time, in all my four years of study I do not recall a single practical problem of structural design given by any member of the faculty, nor was there any express or formal opportunity for a student to confer with an instructor regarding his work except as he might seize it for a few minutes at the end of a recitation or lecture. Assignments in textbooks or lecture notes were given daily for preparation before the next exercise, and the student was expected to prepare himself for a drastic test, and not one escaped in that daily routine.

At the present time, on the contrary, from the beginning until the end of every day, he has constantly recurring opportunities to consult with instructors at almost any hour; and for considerable portions of the day he is expected to work out his problems and other design exercises under the direct aid and explanation of an instructor.

While the present procedure is certainly more merciful and in large degree helpful, I am by no means certain that the advantages are all in the modern practice. The old plan, drastic and unfeeling as it was, certainly bred men, men of self-reliance, of capacity for initiative and with a resolution and vigor in professional duties that are not too frequently in evidence at the present time.

I have heard a high administrative officer of one of our larger American universities say that he desired to have instruction work so administered that a student might call at any time whatever upon an instructor for any aid which he might desire. It is probably needless to say that that particular administrative officer had never had a day's experience in instruction work in his life. Such a system of day-nursing demoralizes and weakens the student's fiber, and a more perfect system of destroying initiative and self-reliance on the part of a young man cannot easily be devised.

SPECIALIZATION HAS RUN RIOT

There is no doubt of the fact that on the whole the present system of engineering study is in effectiveness a substantial improvement upon that which prevailed thirty or forty years ago, but we have by no means got to that point where we can afford to ignore the lessons of the past. Specialization has run riot in engineering education and gone to seed in such a way as to give the special graduates a maximum capacity of adaptation to a narrow range of work with a minimum of educational effect. If it is the intention to make graduates of engineering schools educated men as well as adapted to their field of professional work, it will be necessary to restrict materially the specialization now existing. The true aim of an engineering school should be to give its graduates not only an adaptation to the conditions of work in their future professional activity, but also to make them broadly educated men and give a due quality of scholarship to their service. In other words, to develop and equip them for well-rounded and general competency rather than narrow facility. The former will make by far the strongest professional man in his life work, and that should govern.

THE IMPORTANCE OF TEACHING THEORY

I have always emphasized the teaching of engineering theory, and it passes my understanding how any instructor in a professional engineering school can attain to even the poorest form of engineering instruction without not only teaching engineering theory, but giving it first place in his work, and I say this deliberately in view of the fact that I have been an active practicing engineer from the time of my graduation to the present day, and I expect to remain so for the remainder of my life.

If there is any way of making an effective professional engineer without founding his educational training or knowledge on engineering science, I admit openly that I do not know what it is; and if there is any other method of conveying a knowledge of that science than by teaching engineering theory, I have never yet discovered it.

The marked advances made in the modern engineering schools stand obviously among the great achievements of university work, and there is little else but praise to be given to those who are conducting them. There are, however, some respects in which the contrast between the older schools and those now existing is not altogether in favor of present practices. Among the chief aims of every professionel school ought to be attainment by students of initiative, self-reliance, decisive and resolute treatment of professional work. The great numbers of students now collected in these schools and the necessity of systematic and effective administration have caused some serious misdirected efforts. . . .

The university is not a factory, as President Butler has repeatedly said in his annual reports. It is not the province of the university to force in a machine-like way its students through grooves and dies, or to submit them to the standardizing operations of educational lathes and planers so as to produce interchangeable parts of machines rather than educate and develop individuals each with his own creative power brought to its best effective condition.

THE PASSION FOR CHANGE

Again there has gradually crept into the educational life of engineering schools what I think may be properly called, for lack of something better at least, the vaudeville, a kind of raw, unregulated, but well-meaning desire to change abruptly about everything which has been found effective in long experience by a more or less chaotic and unreasoned effort to gain improvement, without realizing that a good deal of the best may be wrecked in the procedure.

It is probably unnecessary for me to say that all the solicitations of the vaudeville have not attracted me. There is nothing more effective in the extension and development of an engineering school than excellent things quietly and well done; and the more work of that sort performed the greater and more enduring will be the service rendered to the profession.

Bear Valley Multiple-Arch Dam Overflows for First Time

The new Bear Valley dam, one of the largest of the multiple-arch concrete type, overflowed for the first time on Jan. 21, 1916, as shown in the accompanying view from a photograph taken on that day. This dam, located in the San Bernardino Mountains of California, was described in *Engineering News*, Dec. 25, 1913, p. 1284. It was built upstream of the famous Bear Valley arch dam, which for many years held the record for slenderness of

WATER GOING OVER BEAR VALLEY DAM ON JAN. 21, 1916

section. It is of interest to quote the following extract from the article mentioned:

It was proposed to erect a dam to a height of 65 ft. above the base datum zero of the old dam, giving a capacity in millions of gallons of 17,000, but the large runoff of the winter of 1909 showed that there would have been lost a considerable quantity of water at that height, so it was finally determined to run it up to the 70-ft. contour, giving it a capacity of 21,000 millions of gallons and this in the completed plans was raised finally to the 72-ft. contour, giving a capacity of 22,880 millions of gallons, the new datum giving a crest elevation of 6,746 ft. above sea level.

The photograph was furnished by Herbert Garstin, President of the Bear Valley Mutual Water Co.

Health Nuisances Prohibited in New Jersey

Nuisances having a relatively direct effect upon health are dealt with in a half dozen short regulations in the initial portion of the State Sanitary Code just adopted by the New Jersey Department of Health. The regulations are as follows:

1. No person or private or municipal corporation shall maintain or permit to be maintained anything whatsoever which is a hazard or a danger to human health.

2. No person or private or municipal corporation shall maintain any well, or other supply of water used for drinking or household purposes, which is polluted in any manner that may render such water injurious to health, or which is so situated or constructed that it may become so polluted.

3. No person or private or municipal corporation shall maintain, use or permit to be used, any privy or other receptacle for human excrement, unless such privy or other receptacle is so constructed and maintained that flies cannot gain access to the excremental matter contained therein, and unless such excremental matter shall at all times be prevented from flowing over or upon the surface of the ground. Every privy or other receptacle for human excrement located within 100 ft. of any stream, the waters of which are used for drinking or domestic purposes, shall be provided with a water-tight vault.

4. No person or private or municipal corporation shall permit any human excrement, or material containing human excrement, to remain on the surface of the ground nor shall such excremental matter or material containing such excremental matter be buried or otherwise disposed of within 100 ft. of any stream, well, lake, spring or other source of water used for drinking or domestic purposes; nor shall any such material be deposited in any place where it is likely to gain access to such waters. Provided, however, that this regulation shall not apply to effluents from sewage-disposal plants which have been, or hereafter may be, approved by the State Department of Health.

5. No person or private or municipal corporation shall maintain, or permit to be maintained, any accumulation of decomposing animal or vegetable matter in which fly larvæ exist on any premises upon which is located any hotel, boarding house, lodging house, restaurant, or any other establishment in which foods intended for sale or distribution are prepared, handled or sold, or at any point on any other premises within 250 ft. of any dwelling occupied by another.

6. No person or private or municipal corporation shall maintain or permit to be maintained, any pool, pond, ditch, stream or other body of water or any cistern, privy vault, cesspool, rain barrel or other receptacle containing water, in which mosquito larvæ exist.

7. These regulations shall take effect on June 1, 1916.

The State Sanitary Code is being framed in accordance with a legislative enactment of 1915. The Code will supersede all local health board rules and ordinances throughout the State but local boards may adopt other and stricter rules not inconsistent with the Code. It is the duty of the State Department of Health to see that not only the State Sanitary Code but the sanitary and health laws of the State as well are enforced. In case of local non-enforcement, the Department has authority to do the necessary work and recover the cost from the municipality in an action for debt.

Detroit Sewage Disposal from International Viewpoint

A $6,000,000 sewage-treatment plant, consisting of sedimentation and Imhoff tanks, followed by disinfection, would be the most economical method of meeting local needs and protecting both American and Canadian interests, according to a report just made by Clarence W. Hubbell, Consulting Engineer of Detroit, to George H. Fenkell, Commissioner of Public Works of that city.

Mr. Hubbell was engaged late in 1914 to review the data and conclusions of the International Joint Commission as to the protection of Canadian waters from Detroit sewage. He was also asked by Mr. Fenkell to consider the extent to which the "sewage of Detroit pollutes American waters so as to render them unfit as a source of raw water for filtration purposes." A third line of inquiry referred to Mr. Hubbell involved the means, if any, which should be used by Detroit to treat its sewage and the expense which would be justifiable for that purpose.

After a general review of the report to the International Joint Commission, as related to Detroit conditions, Mr. Hubbell says:

> It therefore follows that preventive or remedial measures required with reference to pollution crossing the boundary line from either side should logically be limited to such sewage treatment as may be necessary to prevent an undue burden being placed on any water-purification plant having an intake suitably located in the best raw water obtainable within a reasonable distance from the plant. In our [my] judgment such results can best be insured for all future conditions likely to occur, by sterilization of all sewage discharged from vessels, and by eventually collecting all urban sanitary sewage at convenient points where it may be treated either by means of fine screens or settling tanks, followed by sterilization.
>
> Detroit should anticipate such a system for other reasons than that of preventing pollution from crossing the boundary line.

Taking up next the relation of the sewage of Detroit to the water-supplies of nearby American cities, Mr. Hubbell first says that it is difficult to distinguish between pollution from either side of the boundary line. There is a zone "of grossly polluted water" along the whole American shore of the river between Lake St. Clair and Lake Erie. The zone varies in width and the degree of pollution decreases from the shore outward. Within this polluted zone the water is "unfit as a source of raw water for filtration purposes."

The water-supplies of Michigan most affected are those of Ford, Wyandotte, Trenton, and Monroe, but the Detroit sewage does not render the raw water "drawn for the supply of any of these cities" unsuitable for filtration purposes. In the cases of Ford and Wyandotte, water suitable for filtration can be obtained through an intake extending about 3,000 ft. into the river. Trenton is worse off, for it "cannot obtain a suitable supply within reasonable distance or cost" as matters now stand, but it "could do so were Detroit sewage treated as recommended in this report."

The sewage of Detroit does not reach the Detroit waterworks intake crib under ordinary conditions, but strong easterly winds sometimes cause a back flow in the river, especially if they coincide with ice gorges in the St. Clair River. Such conditions are likely to occur once in four or five years and to endanger the supply. The probability of this backflow, combined with increasing unpreventable pollution, surface wash, and storm-water sewage will probably justify the construction of a new waterworks intake further removed from the influence of shore pollution some time in the future, even if Detroit does build sewage-treatment works.

As to the most desirable method and cost of sewage treatment for Detroit, Mr. Hubbell points out first that owing to the large amount of dilution available in the Detroit River, oxidation methods are not required for Detroit sewage. It is desirable, however, to remove oil, grease, feces and other floating matter from the sewage. Most important of all is the removal of disease germs. Elaborating on this point, Mr. Hubbell says:

> Studies indicate that a removal of some 90 to 95% of the total bacteria in the sewage will be necessary to reduce the pollution in the river below Detroit to a standard 500 B. coli per 100 c.c. for average conditions. This can best be done by the use of a disinfectant, such as hypochlorite of lime.

After considering various methods of sewage treatment, Mr. Hubbell says the choice lies between (1) Imhoff tanks with disinfection located at Fort Wayne and Fairview on the river front, and a future plant on Connor's Creek, and (2) five plants in which fine screening would be combined with disinfection. Under the first alternative the sludge would be disposed of by filling in lowlands or by incineration, or sold as a fertilizer. Under the second plan the screenings would be burned.

Although sedimentation and screening would be the most expensive of the two plans in first cost, Mr. Hubbell concludes that this plan is the most desirable one, as it would also be the most economical, taking into account all of the annual charges. He estimates that the first cost of Imhoff tanks and disinfection for a population of 950,000, together with necessary collecting sewers, would be $6,091,000. The annual charges, including interest at 4½%, amortization (rate unspecified), operating cost and maintenance are estimated at $517,430, or 54.5c. per capita. These estimates do not include the future plant on Connor's Creek.

Finally, Mr. Hubbell says that "it is difficult to formulate an answer in terms of money alone" to the question, "What expense would be justified for sewage treatment?" He believes, however, that considering the international features of the problem, the benefits to the water-supplies of Detroit and other cities on the American side and the various amenities of the case that an expenditure of $6,000,000 for construction would be justified.

Mr. Hubbell's report was transmitted to the Mayor and Council of Detroit by Commissioner Fenkell on May 9, without recommendations, but accompanied by a review of the methods and cost of sewage treatment as adopted or proposed by a number of other large American cities.

Canadian Power Development Under Arbitration

The Ontario Government has received a communication from the Government of the United States in reference to the proposed development of hydro-electric power at Chippewa Creek. It points out that American citizens are entitled to the use of half the water of the rapids of the Niagara River and that "it can hardly be expected that the Government of the United States will concede that this right may be curtailed by the diversion of the waters above the Falls on the Canadian side in such a way that they will not be returned to the stream except below the Gorge." The note further suggests that in case the views of the American and Canadian Governments are not in accord on the subject the matter might be regarded as an appropriate one to be referred to the International Joint Commission.

Hon. I. B. Lucas, Attorney General of Ontario and a member of the provincial Hydro-Electric Commission, when interviewed on the subject stated that the Ontario Government had always anticipated submitting the plans of the proposed work to the International Joint Commission. Before the Government had any knowledge of a dispatch from the American Government it had authorized the Hydro-Electric Commission to prepare maps and plans to submit to the Joint Commission for approval in pursuance of the provisions of the treaty. It may have been assumed that this consent would be given largely as a matter of form, but the dispatch from the American Government shows that it will be a matter for some adjustment.

News of the Engineering World

Elmer Lawrence Corthell

Elmer L. Corthell, President of the American Society of Civil Engineers, died at Albany, N. Y., on May 16, 1916, at the age of 76 years. Mr. Corthell had for some time been confined to his bed at his summer home in Massachusetts, but his sickness took a turn for the worse during the past week and he was brought to the hospital in Albany, where he died. A full biography and portrait of Mr. Corthell was published in *Engineering News* of Feb. 3, 1916, as one of the biographies of the current presidents of the four national engineering societies. It is not necessary, therefore, in this place to do more than note the history of his professional life.

After service in the Rhode Island artillery in the Civil War, Mr. Corthell reëntered Brown University, where he had been at the breaking out of the war, and graduating therefrom in 1867, started at that time a continuous service in the profession of engineering. This service comprised railway work in the Middle West; a long and arduous experience on the Mississippi jetties; bridge design and construction, mostly on the Mississippi, Missouri and Ohio Rivers; and finally during the later years of his life an international experience in harbor construction, mainly in South America.

Mr. Corthell's professional honors have been many, not the least of which was the presidency of the great national society, which he held at the time of his death. Only one other president of the American Society of Civil Engineers has died in office, Mr. Ashbel Welch, who died Sept. 25, 1882. Clemens Herschel is senior vice-president of the American Society of Civil Engineers and will succeed to the office of president.

Fire-Protection Convention

The National Fire Protection Association at its 20th annual meeting, held in Chicago May 9 to 11, passed a series of resolutions including the following recommendations: The adoption by municipalities of the building code approved by the Association and of ordinances for systematic inspection of buildings, the passage of state laws for the fire-marshall system, minimum requirements for hospitals and other public institutions, and establishing personal responsibility for damage due to fires caused by carelessness. The more general use of sprinkler and fire-wall protection was advocated. Another resolution advocated inspection by the engineers of the Association of municipal matters relating to fire prevention and protection; these would include water supply, fire equipment, fire alarm system, building code, etc.

The possibility of coöperation by neighboring cities for mutual aid in case of fire was discussed, and it was shown that in many cases the use of individual types of couplings and fittings continues to be a bar to such outside assistance.

The fire protection of high-value districts was a special topic of discussion. Albert Blauvelt (Chicago) advocated the special high-pressure system, and suggested that in promoting the use of such protection more emphasis should be laid on its economic value. H. W. Forster (Philadelphia) spoke very strongly in favor of the automatic sprinkler system, which is adaptable for small as well as large cities. He considered that in most cases the available pressure is ample, without a special high-pressure system. In many cities it is 100 to 150 lb., and Omaha has even 175 lb. for all purposes. In most cities, also, there is willingness to furnish water for fire purposes at little or no cost, the value of the use of such water in preventing conflagration and loss being now recognized.

Greater coöperation of the engineer with the state legislator, the alderman and other political forces was urged by Herman L. Ekern (Wisconsin) as a means of introducing better protection for high-value districts. The engineer's reports alone accomplish nothing, but what is needed is the legislator or alderman who has been educated by contact with the engineer so that he understands what the situation is and what the engineer's report really means to the community.

Specifications for the construction of an office building with the highest practical type of fire resistance were submitted by the Committee on Fire Resistive Construction. Suggestions for the elimination and protection of defects which constitute fire hazards were discussed in another report. Such defects include hollow floors (wood) without firestops, stairway openings and elevator shafts, and floor openings for belting and machinery.

Outside stairs were advocated strongly by the Committee on Safety to Life, and its recommendations were adopted without discussion, although formerly there has been strong opposition to endorsing the use of such stairs. This committee also called attention to the laws of New York and Wisconsin which base the allowable number of occupants for any floor upon the exit capacity. The suggestions for protection of buildings against lightning, submitted by the Committee on Signaling Systems, led to protracted discussion.

Two subjects of sociological character were presented relative to the protection of children and young people in factories and schools. Miss Mary E. McDowell advocated complusory fire-drill. She referred to disasters in which panic was a leading cause, and laid stress upon the economic loss due to injuries and sickness among those who are not able to support themselves except by their daily work. Even in a fireproof building with good fire protection, a slight fire or other cause of panic on an upper floor may result in a terrible disaster.

The other matter was a discussion on safeguarding children from fire. This covered three specific points: The planning of school buildings with a view to safety, the use of fire escapes and fire drills, and the care of school buildings.

Tests of pipe elbows to determine the friction loss indicated that the loss of standard elbows is 50 to 100% greater than that of long-turn screw-end elbows, and it is proposed to design new standards of the latter

type. The Committee on Explosives and Combustibles submitted amendments to present regulations relative to containers, fuel oil, internal combustion engines, and acetylene generators for lighting.

The meeting was held in the auditorium of the Insurance Exchange Building. The attendance was large and the discussions were active. The officers for 1916-17 are as follows: President, Charles E. Meek, New York, N. Y.; Vice-Presidents, Louis Wiederhold, Jr., Philadelphia, Pa., and D. Everett Waid, New York, N. Y.; Secretary and Treasurer, Franklin H. Wentworth, Boston, Mass.

Elephant Butte Dam Completed

The Elephant Butte Dam, located on the Rio Grande about 14 mi. west of Engle, N. M., and the main structure in the Rio Grande project of the United States Reclamation Service, was officially dedicated on May 13, 1916. The dam is of rubble concrete with a gravity section and straight plan. It is 1,200 ft. long at El. 4,414, the roadway surface, 203.5 ft. high above the original river surface and 304.5 ft. from deepest excavation to top of parapet wall. The maximum width at base is 215 ft. and the roadway top is 16 ft. The masonry content is 550,000 cu.yd. A reservoir was created 45 mi. long and with 42,000 acre area, containing when full 115,098 million cubic feet. Numerous articles describing the design and construction of the dam have appeared in *Engineering News*, notably in the issues of Jan. 16, 1913, p. 120; June 19, 1913, p. 1270; Jan. 14, 1915, p. 51; Sept. 30, 1915, p. 645; Oct. 7, 1915, p. 696.

John Edson Sweet

John Edson Sweet, Hon. M. Am. Soc. M. E., one of the best known and most affectionately regarded men in the entire engineering profession, died suddenly at his home in Syracuse on May 8. He was born in Pompey, N. Y., in 1832, and was there educated in the district schools. He early exhibited his mechanical ingenuity and in 1850 was apprenticed to a carpenter and joiner. After about a year he entered the office of a local architect, where his work attracted more than local attention. From 1862-4 he was a draftsman for Hazeltine, Lake & Co., and the Patent Nut & Bolt Co., in Birmingham, England. On his return to America he was a designer for

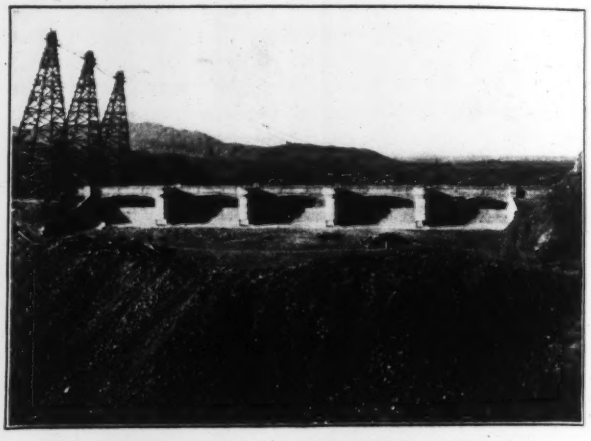


FIG. 2. SPILLWAY ON ELEPHANT BUTTE DAM

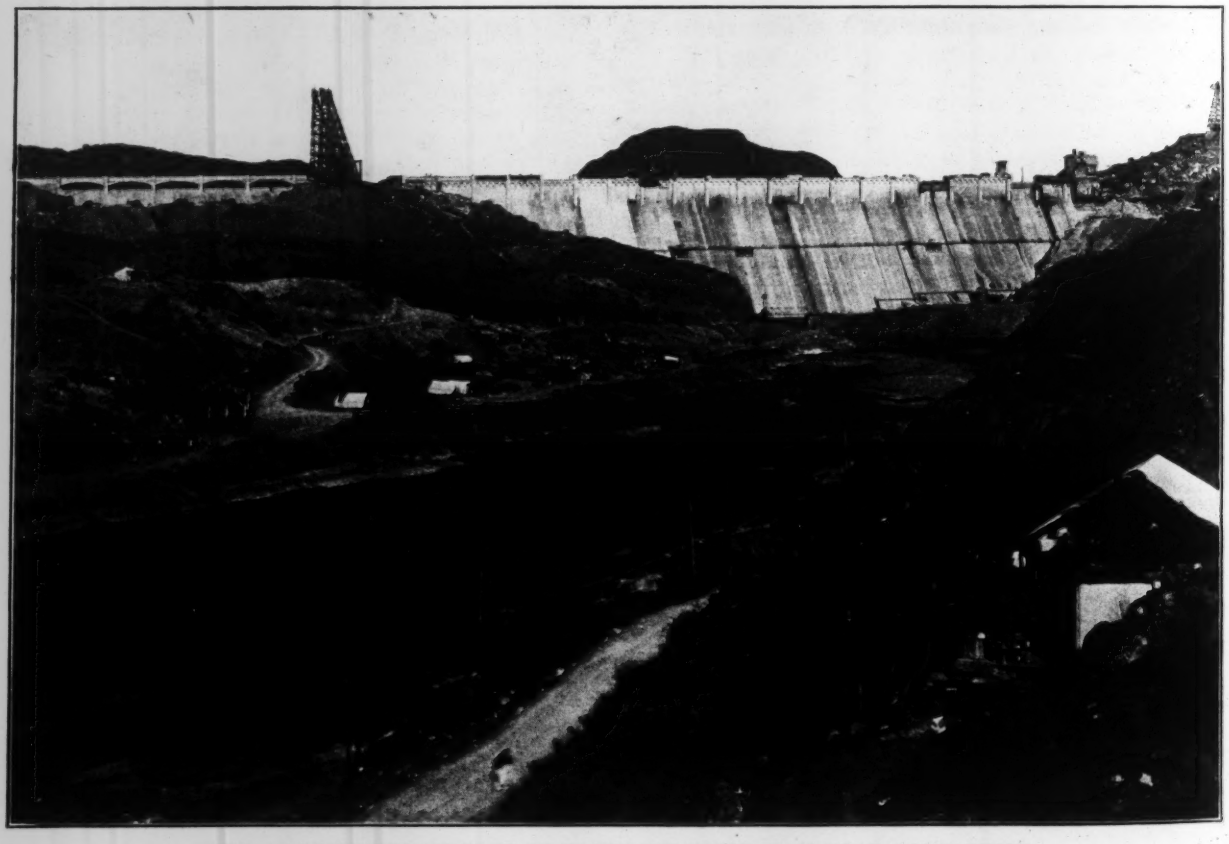


FIG. 1. DOWNSTREAM FACE OF ELEPHANT BUTTE DAM NEAR COMPLETION

Sweet, Barnes & Co., of Syracuse. About this time he devised a typesetting machine, which was exhibited at the Paris Exposition in 1867. From 1871-3 he was a bridge builder for Howard Soule of Syracuse, and in these years built the first of the famous "straight-line" steam engines.

In 1873 he was called as professor of practical mechanics in Sibley College, of Cornell University, and here he laid the basis of his world-wide reputation as an engineer, and in spite of only six years of teaching made those notable friendships which clung to him with his title "Professor" to the end of his life.

He left Cornell to take up the commercial development of his Straight-Line engines—the success of which has become a matter of record. The shops of the Straight-Line Engine Co., of which concern he became president in 1880, became a notable institution because of the quality of its work and the spirit which pervaded it. Over its entrance was written "Visitors Always Welcome."

Professor Sweet was one of the leaders in the founding of the American Society of Mechanical Engineers, and its third president, in 1883. From 1899 to 1901 he was president of the Engine Builders' Association of the United States. He was always active in local technical affairs, having been, for example, president of the Syracuse Technology Club and of the Syracuse Metal Trades Association. He had served as mechanical expert for the U. S. Navy Department and in 1893 was one of the jurors at the Chicago Exposition. In 1906 he was president of the John Fritz Medal Association. Syracuse University conferred on him the honorary degree of Doctor of Engineering.

From his earliest days in the Syracuse architect's office he had been a facile writer and his contributions to technical publications were numerous. In 1906 he published the volume "Things That Are Unusually Wrong"—discussing features of machine design.

Cloud Clifford Conkling

Cloud Clifford Conkling, M. Am. Soc. C. E., Chief Engineer of the Steel Sheet Piling Department of the Lackawanna Steel Co., died on May 8, at his home in Buffalo, N. Y. He was born in Rensselaerville, N. Y., in 1862, and attended the public schools of Scranton, Penn. He continued his studies, including civil and mining engineering, and was first employed, in 1881, as rodman on the Erie & Wyoming R.R. and in a similar position during the following year on a water-supply survey of the Ramapo Valley, New York.

In 1882 and 1883 he also took a special course of study at Williston Seminary, Easthampton, Mass., and the next two years was draftsman and transitman in the city engineering office of Scranton. He was also engaged on a railroad survey in New Jersey under J. H. Rittenhouse. He served for 12 years in the National Guard of the State of Pennsylvania, retiring as Sergeant Major of the 13th Regiment.

In 1886, Mr. Conkling entered the Department of Civil and Mining Engineering of the Lackawanna Iron and Steel Co., as rodman, continuing with that company (now the Lackawanna Steel Co.) in various capacities. He was made transitman in 1888; Assistant Engineer in 1892; and Chief of the Department in 1894, since which time he had had charge of all the construction work for the company, and entire charge, for the first year and a half, of the construction of the company's Buffalo plant, the design and construction of railroad yards, sewers, canals, harbor work, the South Buffalo R.R. and foundations of all kinds.

Mr. Conkling was Chief Engineer of the South Buffalo R.R.; Chief Civil Engineer of the Lackawanna Steel Co. up to 1904, when he left the direct employ of the company to practice consulting civil engineering in Buffalo, during which time the surveys, plans and estimates were made for the Buffalo, Depew & Lake Erie R.R., a terminal freight railroad to be built around the City of Buffalo.

In 1907 the original design of Lackawanna steel sheet piling was patented. Mr. Conkling designed and patented modifications of the original design and was instrumental in bringing to a commercial culmination the shapes of Lackawanna steel sheet piling now rolled by that company. In 1913 the consulting work of this character had reached such a magnitude that Mr. Conkling returned to the Lackawanna Steel Co. as Chief Engineer of the Steel Sheet Piling Engineering Department, which position he held until the time of his death.

Automobile Makes Record Across Continent

An automobile (Cadillac stock eight-cylinder roadster) driven by E. G. Baker and W. F. Sturm, of Indianapolis, made the transcontinental trip from Los Angeles to New York City in 7 days, 11 hr. 53 min. The start was made from Los Angeles on May 8 at 12:01 a.m. and finished May 15 at 2:53 p.m., covering a total distance of 3,471 mi. Throughout the trip the two men secured about 18 hr. sleep.

The Keaumuku Road on Hawaii, which encircles the entire island, is about complete. It is 240 mi. long. The round journey can be made by automobile in two days.

Municipal Ownership of Gas and Electric Light plants at Phoenix, Ariz., is proposed, with the possible purchase of electric current from the Roosevelt Dam hydro-electric plant of the United States Reclamation Service. Preliminary plans and estimates are to be made by Burns & McDowell, consulting engineers, Interstate Building, Kansas City, Mo.

A Disastrous Fire in Ellendale, N. D., on May 10, practically destroyed the town. The damage is estimated at $400,000, the insurance at $150,000. The fire started at night in a livery stable and was soon distributed about the town by a 40-mi. gale. The local fire department was inadequate to cope with such an emergency and 85 buildings were burned—which left only a half-dozen standing—before aid could be obtained from outside.

A Washout on a Concrete-Lined Ditch caused damage recently at Sioux Falls, S. D. To prevent the flooding of valuable land a flood-diversion ditch was cut from one channel of the river to a parallel channel, the ditch ending in a concrete-lined chute down a bluff. The toe of the concrete not being protected, a flood in the river scoured it out so that it failed, and the chute was broken. The current of water coming from the ditch scoured out a deep cut in the face of the bluff.

The New York City Bridge Department is to be superseded by a new and larger Department of Plant and Structures, according to the provisions of a bill recently made law by the governor's signature. The new scheme was fully outlined in "Engineering News," Apr. 13, 1916, p. 722. The main change will be the inclusion under one head of the 71 repair shops now operated separately by various municipal departments.

A Building-Trades Strike in St. Louis was called at noon on May 6. The number of workmen involved is given as 7,000 and the cause of the strike is the refusal of an increased wage scale by the contractors of St. Louis. Local reports

state that every contractor in St. Louis is affected by the strike, with the exception of eight small concerns who have signed agreements with the unions. The big contractors refuse to recognize the International Union of Hod Carriers.

Free Automobile-Parking Spaces are being built in St. Louis to take care of the conditions that will obtain after May 27, when an ordinance goes into effect prohibiting the parking of automobiles for more than two hours in the streets of a defined congested district. The construction of the parking spaces started on May 7. Red signs designating the congested district will be placed under all street signs at the corners in the section in which parking is prohibited. Only licensed taxicabs will be permitted to park for more than two hours in the congested district.

Dry Dock No. 1 at Balboa, the Pacific terminus of the Panama Canal, has been practically completed and was turned over by the Division of Terminal Construction to the Mechanical Division for operation and maintenance on May 1. The dock is 1,044 ft. long, 110 ft. wide at the entrance, and has a depth over the keel blocks of 35 ft. at mean tide. The dock was built behind the protection of a coffer-dam. A gap 100 ft. wide was blasted through this coffer-dam on Apr. 23 admitting the water from outside into the lock. The blast was made with 14,500 lb. of 60% dynamite.

Geodetic Connection between Mexico and United States—The Secretary of Commerce announces the completion of the work at the Rio Grande to the westward of Brownsville, Tex., and Matamoras, Mex., which connects the triangulation systems of the United States and of Mexico. In the United States the arc of primary triangulation extends from the northwestern part of Minnesota southward along the 98th meridian to the Rio Grande, and Mexico had extended an arc of primary triangulation along the 98th meridian from its Pacific coast to the Rio Grande. The length of the completed arc is 2,270 miles.

Double-Tracking on the Chicago & Northwestern Ry. for about two miles west of Cedar Rapids, Iowa, will complete the double-tracking between Chicago and Omaha. The grading is very light (about 25,000 cu.yd.), and all excavation will be done by hand. Part of the roadbed widening is done by shoveling direct from borrow pits to make the shallow fill. In cuts, the ground is plowed and the earth shoveled into 1½-yd. Western dump cars on a construction track of 2-ft. gage. With this small equipment, the work can be done along the edge of the roadbed without interfering with traffic. The contractors are White & Duffy, of Chicago. The work is under the direction of M. E. Thomas, Division Engineer, at Boone, Iowa.

Two California Irrigation District Projects, each pumping water from wells for distribution through pipes, each including booster pumps, and each having as its chief engineer Stephen E. Kieffer, 57 Post St., San Francisco, Calif., will reach the contract stage the latter part of June. The Lindsay-Strathmore Irrigation District (Secretary, C. W. Wright, Lindsay, Calif.) expects to vote $1,400,000 of bonds to irrigate 15,775 acres of citrus lands. It proposes to sink 37 wells upon a 1,200-acre tract in the Kaweah River delta. The wells are expected to give a total yield of 75 cu.ft. per sec. or 26,000 acre-feet for the season. Each well will be equipped with a direct-connected electric-driven deep-well turbine pump, operating under a total head of 100 ft., delivering into a 60-in. reinforced-concrete pipe 3½ mi. long. This pipe will deliver into a reinforced-concrete-lined low-level ditch 6.25 mi. long, having a grade of 1.92 ft. per mi. At the lower end of this ditch three 16-in. horizontal, single-stage centrifugal pumps direct connected to 500-hp. motors and two 10-in. pumps of the same type with 200-hp. motors will deliver water against a head of 160 ft. into a reinforced-concrete-lined high-level ditch 5.25 mi. long, on a grade of 5 ft. per mi. A boosting station on one of the main pipe lines will lift water 160 ft. more to high-level ditch No. 2, from which pipe will supply the highest land on the district. The boosting station will have two 8-in. pumps like the others just described, driven by 125-hp. motors. The mains and laterals supplied from the two high-level ditches will range in size from 36 to 6 in., total 95 mi. in length, and deliver water under pressure to same point "opposite every tract of land." Pipe above 12 in. will be of "protected" riveted steel and less than 12 in., either the same material or reinforced concrete. The Terra Bella Irrigation District (Secretary, E. R. Clemens, Terra Bella, Calif.) expects to vote $1,000,000 bonds for works to irrigate 12,500 acres, but apparently only half this sum will be expended at the outset. The supply of 65 cu.ft. per sec. will be from about 60 wells and also from "infiltration galleries" consisting of open-jointed cement pipe laid in the bed of Deer Creek. There will be a pump to each well, delivering to a main pumping station, and also five booster stations. The well pumps and the main pumping stations will have equipments similar in type to those for the other district. The main station and booster station No. 1 will contain two 12-in., two [illegible] and two 8-in. pumps and 250- and 125-hp. motors, operating against a head of 120 ft. Booster Station No. 2 will receive infiltration-gallery water and deliver it by means of two 12-in. pumps and 25-hp. motors. Booster Station No. 3 will deliver gallery and well water under 170 ft. head to the same zone as will No. 2, by means of 8-in. pumps and 75-hp. motors. The other two boosting stations will take water from initial boosting stations and deliver it at heads of 80, 100 and 160 ft., these pumps being 4- and 6-in. The distribution system will comprise 80 mi. of 6- to 30-in. pipe, of material similar to that in the other district, delivering water at a point opposite every 20-acre tract.

PERSONALS

Mr. J. C. Townley has been appointed City Superintendent of Ithaca, N. Y., succeeding Martin Conlon.

Mr. Hugh Bennett has been elected Commissioner of Public Works at Ada, Okla. Mr. Bennett was formerly employed as a driver by the Ada Ice and Cold Storage Co.

Mr. W. L. Miller, formerly Superintendent of Construction and Distribution of the Northern States Power Co., has been appointed Manager of the Interstate Power Co., with headquarters at Galena, Ill.

Mr. William Cotter formerly President of the Pere Marquette R.R., has been elected President of the Manufacturers' Ry. and the St. Louis & O'Fallon Ry. He succeeds George F. Moore, who has resigned on account of ill health.

Mr. William E. Foss, M. Am. Soc. C. E., has been appointed Chief Engineer of the Metropolitan Water and Sewerage Board of Massachusetts. He has been Acting Chief Engineer since the death of Dexter Brackett in August, 1915.

Mr. J. F. Carmichael has recently resigned as Construction Foreman with Montague-O'Reilly Co. to take a similar position with A. Guthrie & Co. on the lining of the Oregon-Washington R.R. & Navigation Co.'s tunnel at Portland, Ore.

Mr. W. Cooper Campbell, Assoc. M. Am. Soc. C. E., has resigned as Superintendent of Public Works of Columbus, Ga. He will be located in Charlotte, N. C., where he recently secured a $100,000 street and sidewalk paving contract with that city.

Mr. F. L. R. Francisco, M. Am. Soc. C. E., Consulting Engineer, New York City, has been named by Mayor Thompson of Chicago as the city's representative on the Board of Supervising Engineers of the Railway Terminals Commission. Mr. Francisco succeeds E. W. Bemis.

Mr. O. E. Thomas has been appointed District Sales Manager of the Terry Steam Turbine Co., Hartford, Conn., for a territory covering Arizona and the southern portions of California and Nevada. His headquarters will be at 626 Washington Building, Los Angeles, Calif.

Messrs. William H. Coverdale, M. Am. Soc. C. E., and Walter W. Colpitts, M. Am. Soc. C. E., announce that the practice of W. H. Coverdale & Co., Inc., Consulting Engineers, will hereafter be conducted under the firm name of Coverdale & Colpitts, at 66 Broadway, New York City.

Mr. Edward R. Stapley has resigned as Instructor in Civil Engineering at Cornell University to become Resident Engineer of Wilson, N. C., which now has under construction a system of water-works, a municipal gas plant, and street-paving work to the amount of a half million dollars.

Mr. Schley Gordy has been elected Superintendent of Public Works of Columbus, Ga. He fills the vacancy caused by the resignation of Mr. Cooper Campbell. Mr. Gordy is a graduate of the Alabama Polytechnic Institute and has been assistant to Mr. Campbell for the last six years.

Mr. Frank Strong has been appointed Division Engineer of Maintenance-of-Way of the Salt Lake division of the San Pedro, Los Angeles & Salt Lake R.R. to succeed R. K. Brown, promoted to Engineer of Maintenance-of-Way of that railroad. Mr. Strong's headquarters will be in Salt Lake City, Utah.

Mr. Earle B. Norris, M. Am. Soc. M. E., for several years past Associate Professor of Mechanical Engineering at the University of Wisconsin, has been engaged as Industrial Commissioner of the St. Paul (Minn.) Association of Commerce. Mr. Norris graduated from Pennsylvania State College in 1904, and has since had wide experience in varied manufacturing lines, including agricultural-implement and automobile factories.

OBITUARY

Prof. Leon Henri Carbonnier, former Chancellor of the University of Georgia, died at Augusta, Ga., on May 3. He was born in Lorens, Brittany, in 1837, and educated at St. Cyr, the French military academy. Prof. Carbonnier came to America during the Civil War. He enlisted in the Confederate Army and at the close of the war was selected to create a department of engineering at the University of Georgia. He was later elected to the chair of physics and astronomy.

Henry Rohwer, M. Am. Soc. C. E., Consulting Engineer, died at his home in St. Louis, Mo., on May 7, at 68 years of age. He was born in Holstein, Germany, and studied in the technical schools there. In 1869 he came to the United States and immediately was engaged as Chief Engineer on the construction of the Burlington & Missouri River R.R. in Nebraska. In 1876 he was appointed City Engineer of Omaha, in which capacity he served for five years. Later he was connected with the Oregon Short Line R.R., Omaha Belt Ry. and Missouri Pacific Ry. He was Chief Engineer of the last-mentioned railroad from 1901 to 1905 and Consulting Engineer for the system until he took up private practice several years later.

William Stanley, Fel. Am. Inst. E. E., former head of the Stanley Electric Manufacturing Co. and Stanley Instrument Co., died at his home in Great Barrington, Mass., on May 14, in his 59th year. Mr. Stanley at the age of 32 built the first alternating-current device adapted to the transmission of light and power over great distances. He held the Edison medal, regarded as the highest award for electrical attainment in this country. He was born in Brooklyn and graduated from Williston Seminary, Easthampton, Mass. He entered Yale University in 1881, but left before completing his course to take up experimental work. From 1885 Mr. Stanley was Chief Engineer of the Westinghouse Electric Co., and in 1890 became head of the Stanley Electric Manufacturing Co. He was connected with the Stanley Instrument Co. from 1898 to 1903.

ENGINEERING SOCIETIES

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 12-16. Summer meeting (cruise on Lake Huron and Georgian Bay). Secy., Coker F. Clarkson, 29 W. 39th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.
June 14-21. Convention in Atlantic City. Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
June 19-21. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
June 19-22. Annual meeting in Charlottesville, Va. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

NATIONAL GAS-ENGINE ASSOCIATION.
June 27-29. Annual convention in Chicago. Secy., H. R. Brate, Lakemont, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

The Air Brake Association held its 23rd annual meeting at Atlanta, Ga., May 2 to 5. The officers elected were President, T. F. Dow; vice-presidents, C. H. Weaver, C. W. Martin, and F. J. Barry; chairman of the executive committee, T. F. Lyons; secretary, F. M. Nellis.

The Canadian Railway Club at its recent annual meeting elected the following officers: President, R. M. Hannaford; vice-presidents, G. E. Smart, Prof. Keay; treasurer, W. H. Stewart. James Powell, Chief Draftsman, Motive Power Dept., Grand Trunk Ry., Montreal, was reëlected secretary.

The Georgia Drainage Association held its annual meeting at Monroe, Ga., May 3 to 5. The need of draining Georgia swamp lands was discussed. These lands compose one-fourth of the area of the state and amount to 2,700,000 acres. It is proposed to introduce legislation giving state aid to communities desiring drainage.

The American Institute of Chemical Engineers will hold its eighth semi-annual meeting in Cleveland, June 14 to 17. The usual number of inspection trips will be made. A smoker and entertainment will be given by the local committee at 9 p.m., June 14, while the banquet will be held at the Statler Hotel on June 15. Among the papers to be presented is "Purification of Sewage by Aeration in the Presence of Activated Sludge," by Edward Bartow.

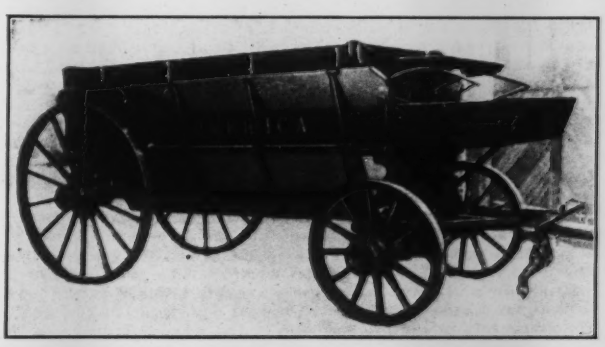
American Association of Engineers—The first annual meeting was held at the rooms of the Western Society of Engineers, Chicago, on May 9 and 10. A session was held each afternoon, but soon adjourned as only about a dozen members were present. No technical papers were presented. About 100 members and guests attended the dinner, at which addresses on military preparedness in relation to the engineer were made by Capt. Reilly (Illinois National Guard), Henry A. Allen, consulting engineer, and others. The report of the secretary showed a membership of over 600, and reviewed the association's activities in regard to securing positions for engineers. A resolution was passed offering assistance to the United States Government in securing lists of engineers, with a view to military organization. The president elected for the year 1915-16 is Garrison Babcock, consulting engineer, Chicago. Arthur Kneisel, Chicago, is secretary.

Appliances and Materials

Dump Wagon with Door Control

The dump wagon shown in the accompanying view has individual control of the bottom doors as one of its special features. To release the doors, the driver presses his feet on a pair of pedal levers, thus withdrawing the lugs that hold the carrying rods. Each door can be closed by one movement of a cam lever. To enable two kinds of material to be carried in one load, or two half loads to be delivered on different jobs temporary partition is placed lengthwise in the middle of the wagon.

The body is 72x38 in. at the bottom, with sides flaring to 82x48 in. at the top. Its height is about 5 ft. The capacity is 1½ yd. within the fixed sides, or 2 yd. with the hinged



DUMP WAGON WITH SEPARATE DOOR CONTROL

sideboards raised. The doors are about 21x76 in., each with four heavy iron hinges across the full width. These are supported by rods of 1¾-in. steel, which carry the greater proportion of the load and distribute the weight equally between the axles. The wheels are 36 and 54 in. in diameter, with 4-in. tires (3-in. if desired). The wheelbase is only 7 ft. 2 in. The 2-yd. wagon weighs complete about 2,000 lb. There is a larger size having a capacity of 3 to 4 yd. These wagons are manufactured by the American Dump Wagon Co., Cedar Rapids, Iowa.

Country-House Water-Works

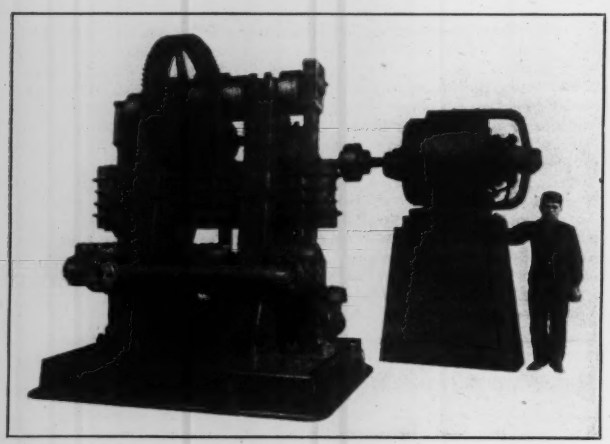
A complete and self-contained pump and storage-tank unit for farms and country houses, known as the "Electri-Pression" outfit, has been designed by the Hill Pump Co., of Anderson, Ind. On an iron sub-base are a motor-driven pump, automatic switch, air valve, water-relief valve, suction- and service-pipe connections and pneumatic-pressure storage tank. The pump ordinarily starts when the pressure drops to 25 lb. per sq.in. or below, and power is cut off at 40 lb.

* * *

Large High-Pressure Pump

The accompanying view shows a new vertical triplex pump designed and built recently by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, for delivering a large volume of water against a high pressure. The capacity depends on the size of plungers—4- to 5¾-in. being used, giving capacities respectively of 88 gal. per min. against 1,700 lb. per sq.in. and 183 gal. against 800 lb. The stroke is 12 in. and the normal speed 45 strokes per min.

On account of the large volume of water handled, each cylinder is equipped with pot valves for both the suction and delivery chambers, allowing lighter checks with smaller lift,



TRIPLEX PUMPS WITH POT VALVES FOR EACH CYLINDER

cutting down the slip from that of single-valve triplex pumps of large water capacity.

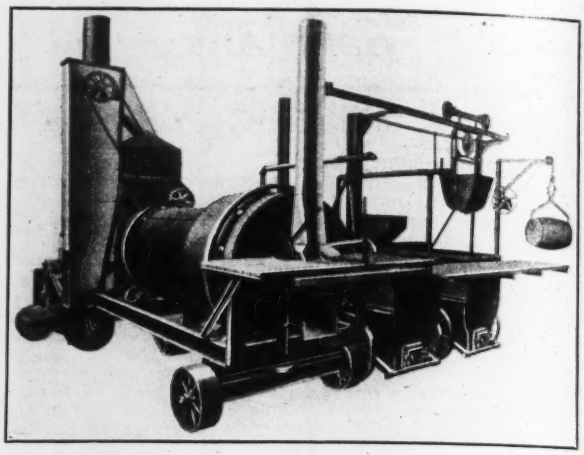
This pump is designed for direct-connected motor drive only and requires 100 hp. It has a double reduction of gears, the first being 5 to 1 and the second 3 to 1. The height of the pump is 10 ft., while the floor space of the pump without the motor is 8 ft. by 5 ft. 9 in.

* * *

Portable Asphalt Plants

Asphalt plants of the designs evolved by Warren Brothers Co., of Boston, for their own work of laying bituminous pavements and roads are now being sold to all who desire to purchase. One of the most useful of their designs has proved to be the portable plant, which had to be low in first cost and maintenance, but sufficiently mobile for use for street repairs and small contracts and on state and county roads. Such a plant, as shown in the accompanying view, comprises a boiler and engine, storage bin, continuous bucket elevator, revolving drier and mixer, two melting kettles and a barrel hoist.

In operation a batch of mineral aggregate (about 3,000 lb.) is loaded into measuring wheelbarrows, dumped into the elevator and held in the storage bin until the previous batch leaves the drier. Then the fresh charge is discharged from the bin through an outlet gate, controlled by the operator on the mixing platform. Thus there are five batches at the plant —one just discharged from the mixer, one in the mixer, one in the drier, one in the bin and one in the wheelbarrows. In the drier a spiral flight carried by the shell works the material forward to a reversing gate that discharges back toward the drier center or forward into the mixer. In the mixer compartment a spiral flight on the shell works the charge forward, and a reversed interior spiral works the top of the batch backward. Oil fuel is burned in a combustion chamber and the hot gases passed through the drier and mixer. It is reported that asphalt topping, open mixture or Topeka-specification mixture can be mixed equally well and without changes of plant. A batch is kept large enough so that good uniformity of product is maintained. Eleven men are required for full-capacity operation.



WARREN'S PORTABLE ASPHALT PLANT

The entire plant except the two kettles is mounted on one truck, weighing 29,000 lb. The plant with kettles, tools, etc., weighs 39,500 lb. The boiler is rated for 35 hp. and is built acording to the A. S. M. E. code. The engine has an 8-in. cylinder and 6-in. stroke. Such a plant costs complete $5,500 (f.o.b. Boston).

* * *

Gyratory Sand Screen

A portable sand screen for contractors and foundrymen has been put on the market by the Great Western Manufacturing Co., Leavenworth, Kan. The device, a view of which is shown in the accompanying figure, is called the Combs Gyratory Riddle. It consists of a frame carrying at its bottom a removable sieve and hung from its top crossbar a shaft

COMBS GYRATORY RIDDLE OR SAND SIEVE

which pivots at the top and which at the bottom revolves around a circular guide. This shaft, driven by a Westinghouse totally inclosed ½-hp. vertical motor, imparts the gyratory motion that sifts the sand. The sieves may be removed at will, either to dump oversizes or to change the mesh. The machine may be hung from a crossbeam or a trolley.